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Economic Analysis of Proposed and Interim Final Effluent Guidelines Integrated Iron and Steel Industry

Temple, Barker and Sloane, Inc, Wellesley Hills, Mass

Prepared for

Environmental Protection Agency, Washington, D C Office of Planning and Evaluation

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Temple, Barker & Sloane, Inc.
15 Walnut Street
Wellesley Hills, Massachusetts 02181

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An initial analysis of the economic impact of the proposed Phase II water effluent guidelines upon the Integrated Iron and Steel Industry was performed. The most likely impact in terms of capital expenditures will be $2.3 billion for 1975 through 1983. Of this, $1.4 billion will be required to meet BPCTCA standards and $0.8 billion to meet BATEA standards. Annual operating costs should increase 0.5 percent during the next decade. The increase to the consumer will be less than 1.0 percent.

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ECONOMIC ANALYSIS OF PROPOSED AND INTERIM FINAL EFFLUENT GUIDELINES

INTEGRATED IRON AND STEEL INDUSTRY

Prepared for

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF PLANNING & EVALUATION

by

TEMPLE, BARKER & SLOANE, INC.
15 WALNUT STREET
WELLESLEY HILLS, MASSACHUSETTS 02181

MARCH 1976

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PREFACE

The attached document is a contractor's study prepared for the Office of Planning and Evaluation of the Environmental Protection Agency ("EPA"). This study is a partial report taken from a larger study entitled "Economic Impact of Environmental Regulations on the Integrated Iron and Steel Industry" which gives consideration to all environmental standards. The purpose of the study is to analyze the economic impact which could result from the application of alternative effluent limitation guidelines and standards of performance to be established under sections 304(b) and 306 of the Federal Water Pollution Control Act, as amended.

The study supplements the technical study ("EPA Development Document") supporting the issuance of proposed regulations under sections 304(b) and 306. The Development Document surveys existing and potential waste treatment control methods and technology within particular industrial source categories and supports proposal of certain effluent limitation guidelines and standards of performance based upon an analysis of the feasibility of these guidelines and standards in accordance with the requirements of sections 304(b) and 306 of the Act. Presented in the Development Document are the investment and operating costs associated with various alternative control and treatment technologies. The attached document utilizes these engineering cost estimates but aggregates them differently for the purpose of estimating the broader economic effects which might result from the required application of various control methods and technologies. This study investigates the effect of alternative approaches in terms of product price increases, effects upon employment and the continued viability of affected plants, effects upon foreign trade and other competitive effects.

The study has been prepared with the supervision and review of the Office of Planning and Evaluation of EPA. This report was submitted as a partial report toward fulfillment of Contract No. 68-01-2832 by Temple, Barker & Sloane, Inc.

This report is being released and circulated at approximately the same time as publication in the Federal Register of a notice of proposed and interim final rule making under sections 304(b) and 306 of the Act for the subject point source category. The study is not an offical EPA publication.

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It will be considered along with the information contained in the Development Document and any comments received by EPA on either document before or during rule making proceedings necessary to establish final regulations. Prior to final promulgation of regulations, the accompanying study shall have standing in any EPA proceeding or court proceeding only to the extent that it represents the views of the contractor who studied the subject industry. It cannot be cited, referenced, or represented in any respect in any such proceeding as a statement of EPA's views regarding the subject industry.

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ACKNOWLEDGMENTS

A study of this complexity cannot be undertaken without the cooperation of many individuals. From the outset, Temple, Barker & Sloane, Inc. (TBS) worked closely with a committee of top level industry executives organized by Dr. S. Fletcher of the American Iron and Steel Institute (AISI). This AISI committee was chaired by Mr. W. Lowe of Inland Steel and included Messrs. F. Armour of National Steel, D. Brewster of Inland Steel, J. Lowey of Republic Steel, and E. Mallick and B. D. Smith of United States Steel (USS). TBS would like to express its appreciation for the contribution made by the members of this committee.

A number of other steel industry representatives also contributed to this study. Mr. B. D. Smith of USS and his staff, including Messrs. W. Renner, R. Ganem, L. Van der Veer and A. Skirboll, were particularly helpful. Throughout the TBS study, these USS representatives provided valuable industry perspective and insightful comments. We would like to offer our special thanks to Mr. R. Ganem. Messrs. D. Hawley of Inland Steel and A. Monnett of USS provided TBS with valuable assistance in the area of forecasting domestic steel shipments. In addition to Dr. Fletcher, other staff of the AISI making contributions include Messrs. F. Langenberg, J. Collins and E. Sommer.

The TBS study utilized detailed industry operating data collected by Arthur D. Little for the AISI. Interpretation of these data was provided by Messrs. S. Margolin, K. Parmeswaran, T. Rothermel and J. Stevens.

Individuals from several organizations assisted in developing the detailed cost equations for pollution control equipment. Among these were Messrs. T. Centi and J. Boros of NUS/Cyrus Rice Division, P. Beltz and J. Varga of Battelle Columbus Laboratory, J. O'Connor and R. Jenkins of the Environmental Protection Agency's (EPA) Office of Air Quality Planning and Standards, and E. Hall, W. Hunt, E. Delaney, J. Williams and P. Williams of the EPA's Effluent Guidelines Division.

EPA's Office of Planning and Evaluation provided direction throughout this project. Messrs. A. Brueckmann, S. Besse and J. Kamihachi guided TBS' effort, providing perspective, assisting in data collection, and undertaking more than their fair share of the unpleasant tasks associated with a project of this scope. Messrs. A. Alm, P. Brands and R. Gamse offered valuable comments and encouragement.

TBS' staff was augmented during the study by several key professionals from other organizations. Professor S. Bradley of the Harvard Business School assisted in the development of PTm(Steel), a computer-based model of the steel industry. Professor J. Light of the Harvard Business School developed TBS' analysis of capital market conditions in the past and the projections of future conditions. Mr. A. Steinburgh of Resource Planning Associates assisted in the initial stages of the project.

Valuable comments on the draft of this report were received from: Messrs. B. D. Smith, D. Dilley and R. Ganem of USS; J. Briggs and R. Woodward of Bethlehem Steel; W. Sullivan of the Department of Commerce; R. Crandall and W. Green of the Council on Wage and Price Stability; D. Brazell of the Council of Economic Advisors; and Professor P. Marshall of the Harvard Business School.

While pleased to acknowledge all the assistance it has received during this study, TBS of course takes full responsibility for the study's analysis and conclusions.

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EXECUTIVE SUMMARY

This study provides a summary of the economic impact of environmental regulations on the steel industry conducted by Temple, Barker & Sloane, Inc. (TBS) for the Office of Planning and Evaluation, Environmental Protection Agency (EPA). Its primary objective is to provide both public policy-makers and industry representatives with an independent, in-depth evaluation of the total economic impact of environmental regulations developed within the context of the uncertainties facing the steel industry during the next decade. A secondary objective has been an evaluation of the impact of the recently promulgated Phase II Effluent Guidelines.

To our knowledge this study of the steel industry is unique in its approach--combining the cost impact methodology employed by Arthur D. Little in its study for the American Iron and Steel Institute (AISI) with, for the first time, a computer-based revenue requirement and external financing methodology which permits an integrated analysis of the economic impacts of environmental regulations.

As the foundation for this study, TBS has developed a Policy-Testing model of the steel industry, PTm(Steel). This computer-based model combines the planning assumptions of industry and technical experts with the structural relationships utilized by engineers and accountants.

REPORT COVERAGE

EPA chose as its definition of the steel industry those on-site facilities from raw materials storage yards for coke oven and blast furnaces through finishing mills. Thus facilities for mining, beneficiation and transportation of raw materials to the site of coking and/or ironmaking as well as fabrication facilities are excluded, but facilities used by the steel industry to produce pig iron for foundries and other uses are included. In addition, all other non-steel operations by steel firms have been excluded from the impact analysis reported herein. It is estimated that steel operations as defined herein represented somewhat in excess of 70 percent of the net fixed assets of the major integrated steel companies during the 1972-1974 period.

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In order to utilize detailed operating data compiled by AISI members, TBS limited its analysis to steel operations which produce approximately 93 percent of domestic steel shipments. While extrapolation to total steel operations could be made, extension of the analysis to iron ore and coal mining, beneficiation, transportation, fabrication and other non-steel operations by steel companies would not be advised.

Environmental requirements analyzed herein are limited to those promulgated, proposed and/or anticipated by EPA. They do not include government regulations initiated by other federal agencies; for example, OSHA requirements. In addition, the engineering cost estimates and compliance schedules are based upon compliance by the steel firm at the plant site, not by municipal wastewater treatment facilities.

BASELINE CONDITIONS

In order to discuss the economic impact of environmental regulations on the steel industry, it is important first to establish a point of reference from which comparisons can be made. In so doing, the uncertainties inherent in forecasting conditions within the steel industry which are unrelated to environmental regulations should be segmented from those associated with these regulations. This reference point requires the establishment of a baseline set of conditions which represents anticipated future operating conditions, which excludes the impact of all pending environmental regulations, and which includes the impact of pollution control equipment placed into service prior to 1975.

In establishing a baseline forecast for the steel industry, TBS has assumed that domestic steel shipments will rebound from the recession conditions evident in 1975 to the long-run trend by 1977 and continue to follow the long-run trend through 1983. This baseline forecast results in domestic steel shipments of 120 million tons by 1980.

The economic implications of this baseline can be summarized by focusing on five key indicators--capital expenditures, external financing needs, operations and maintenance expenses, revenue requirements, and average steel price per ton. These baseline conditions in the short and long run are as follows:

SUMMARY OF BASELINE CONDITIONS
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Capital Expenditures	$8.7	$27.5
External Financing Needs	3.8	13.0
O&M Expenses	78.2	282.9
Revenue Requirements	96.1	338.6
Average Price (in 1975 dollars per ton)	$345.28	$365.21

Tables 1 and 2 provide a detailed summary of these economic indicators segmented into the short- and long-run impacts associated with the industry baseline conditions, water pollution control regulations, and air pollution control regulations.

ECONOMIC IMPACT OF WATER POLLUTION CONTROL

Based on the Phase I Development Document published in June 1974, the most recent Phase II Development Document published in March 1976, and other water regulations anticipated but not covered by either Phase I or Phase II Effluent Guidelines, TBS estimates that capital expenditures for water pollution control equipment will total $3.6 billion during the 1975-1983 period, $2.5 billion of which will require external financing.[1] The capital-related charges associated with these expenditures, combined with the costs of operating the additions to water pollution control equipment, will total $5.8 billion. By 1983 these costs, if passed through in the form of higher prices, will increase the average steel price by $9.60 per ton--2.6 percent of the baseline price level.

A summary of the economic impact of water pollution control is as follows:

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[1] *It should be noted that these economic impacts are based upon an assumption that all existing steel facilities will achieve BPCTCA requirements on or before July 1, 1979 and BATEA requirements by July 1, 1983.*

WATER POLLUTION CONTROL EQUIPMENT
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Capital Expenditures	$1.8	$3.6
External Financing Needs	1.6	2.5
O&M Expenses	0.2	2.5
Revenue Requirements	0.7	5.8
Average Price Increase (in 1975 dollars per ton)	$3.42	$9.60

ECONOMIC IMPACT OF AIR POLLUTION CONTROL

Utilizing data from the 1974 Cost of Clean Air report for stack emissions and data supplied by EPA-Durham for fugitive emissions, TBS projects capital expenditures for air pollution control equipment to amount to $3.3 billion in the long run with related external financing needs of $2.1 billion.[2] The revenue requirements associated with these capital expenditures and operating expenses will approximate $5.7 billion and will require a 1983 price increase of $7.15 per ton. This price increase represents a 2.0 percent increase over the baseline price level.

A summary of the economic impact of air pollution control is as follows:

AIR POLLUTION CONTROL EQUIPMENT
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Capital Expenditures	$2.1	$3.3
External Financing Needs	1.9	2.1
O&M Expenses	0.2	2.3
Revenue Requirements	0.9	5.7
Average Price Increase (in 1975 dollars per ton)	$3.82	$7.15

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[2] *This analysis is based upon installation of controls for stack emissions by July 1, 1978 and fugitive emissions by July 1, 1980.*

CAPITAL AVAILABILITY

Some observers of capital market conditions have forecast a shortage of capital in the near future. TBS has projected capital availability by means of three, equally plausible scenarios. The ability of major non-financial corporations to finance their operations appears to be feasible under all three scenarios--the unanswered question is the difficulty of so doing in terms of the cost of capital in the form of interest rate or stock price. The capital availability problem is most relevant to the marginal, interest-sensitive borrower. Normally, these borrowers would include state and local governments, small business firms, and individuals requiring home mortgages and/or consumer credit.

During the last decade the steel industry has depended upon external sources for less than $1.0 billion. These external financing requirements represented only 5 percent of total applications. The $13.0 billion of external financing required for capacity expansion and modernization in the long run represents nearly 40 percent of total baseline applications. Environmental regulations will increase financing needs by $4.6 billion. These latter requirements represent 60 percent of the total application of funds associated with pollution control equipment.

The most serious financing problem, however, exists in the short run when environmental regulations will require $3.5 billion, a near doubling of the financing requirements for expansion and modernization. Nearly 90 percent of the funds used for pollution control equipment in the short run must be financed through external sources. These 1975-1977 capital market requirements pose serious problems for the steel industry.

First, these external financing requirements far exceed historical flows. Second, the industry's level of profitability has seriously lagged the average of all manufacturing firms with the exception of 1974 when the relaxation of price controls and worldwide shortages of both steel and basic raw materials enabled the steel industry to raise its prices and fully utilize its productive capacity. Third, the steel industry has been burdened in the past by a poor assessment by financial analysts and investors in general. From

1970 through 1974, the ratio of market value of common stock to book value for the six major integrated steel firms approximated 0.5. If the steel industry were required to issue common stock under these market conditions to finance its expansion and/or pollution control equipment, the value of the holdings by existing stockholders would be diluted.

Finally, if steel firms were unable to issue common stock at prices near book value, they would have the option of cutting back on expansion plans or modifying the historic debt-to-equity ratio of 30 to 40 percent. If the industry were to finance its expansion and pollution control equipment needs entirely with long-term debt issues, the debt-to-equity ratio would increase to 100 percent by 1983. Even if this mix of debt and equity were acceptable to investors (for example, in terms of interest coverage ratios), the cause for the shift and its magnitude would most likely have an adverse impact upon the current bond ratings of firms within the steel industry. Under these conditions, most steel firms would likely cut back on their capacity expansion plans.

The above-mentioned analysis does not necessarily imply that the steel industry cannot finance its expansion and/or its pollution control requirements in the short run. While there is little doubt that financing these requirements will be extremely difficult, TBS believes that the task is manageable. However, the industry must be able to pass through the increased operating costs and capital-related charges associated with expansion and environmental requirements, including a rate of return on its common equity at least comparable to that realized on average by other manufacturing firms.

OTHER IMPACTS

The regulation and control of air and water pollutants in the steel industry will have other impacts. The most significant of these other effects will concern changes in the industry's consumption of energy and its levels of employment. Minor effects may also be expected in communities where significant amounts of steelmaking are concentrated and in the nation's balance of trade.

ENERGY

Relative to the large energy requirements for steel production, the energy impact of pollution control is small.

Pollution control equipment placed into service during the 1975-1983 period will increase energy consumption by 0.4 quadrillion Btu, approximately 2 percent of the baseline levels. When the energy consumption of pollution control facilities already in place is included, total energy use associated with environmental regulations is calculated to be 0.8 quadrillion Btu, or less than 4 percent of the industry total. The energy requirements to operate all pollution control facilities within the steel industry will be 41,000 barrels of residual fuel oil or equivalent per day.

EMPLOYMENT

The construction, installation and operation of pollution control facilities will create additional jobs. By 1983, compliance with all levels of pollution control guidelines will have created 12,500 additional jobs. In total, more than 14,900 jobs will be required by 1983 to operate pollution control equipment within the steel industry.

In addition to jobs created directly within the steel industry, the manufacture and installation of pollution control equipment will generate an annual average of more than 15,000 jobs in pollution control equipment industries. This employment will, in turn, create additional employment in unrelated industries.

Some reduction in production labor may offset these employment increases. Jobs could be lost if the higher prices due to the cost of pollution control result in a decline in domestic steel shipments. Jobs could also be lost if specific mills or plants were shut down; however, shutting down one operation might require expanding production at another plant. The net effect of either of these conditions would be a decline in employment only to the extent that production is shifted from more labor-intensive operations to less labor-intensive ones or domestic production is replaced by imports and/or substitute materials.

COMMUNITY

The effect on communities of compliance with the proposed environmental regulations will vary by geographic region. Where plants are large and where significant amounts of steelmaking capacity are concentrated (e.g., in Pennsylvania with over 20 percent of steelmaking capacity), closing of processes at one plant may result in additional jobs at another plant nearby. Such community effects require specialized microeconomic analysis of plant-specific data.

EPA has conducted an in-depth analysis of the potential economic effects of pollution control costs on the eight steel plants in the Mahoning Valley region of eastern Ohio. Imposition of pollution controls or any other major increase in production costs is likely to reduce significantly the profitability of these plants. In these situations, the steel firms might elect to curtail operations rather than make the capital investment to meet environmental regulations.

On the basis of the Mahoning Valley study, EPA provided substantial relief from the industry-wide effluent guidelines.

BALANCE OF TRADE

In 1974 steel imports resulted in an unfavorable balance of trade of $3.0 billion, the greatest deficit of the decade. The increased prices implied by the pass-through of all pollution control costs, including a competitive return on common equity, could adversely impact the ability of domestic producers to compete with imports. However, TBS projects that steel customers will face increases in nominal steel prices which will exceed the overall rate of inflation within the economy by only 0.5 percent. In addition, most knowledgeable observers of the steel industry believe that the domestic steel industry is now cost competitive with foreign steel producers. Future capacity expansion and the shift to more efficient steelmaking should increase this comparative advantage.

It is not possible to foresee accurately the final impact of these events on our balance of trade. Net imports of steel is the most difficult measure of demand to forecast since it is directly affected not only by domestic economic developments but by foreign ones as well. In addition, foreign steel has been an instrument of government policy in the past.

GUIDE TO THE REPORT

This report consists of nine sections and related exhibits.

- Section 1 surveys the report coverage and research methodology;
- Section 2 details the cost impact associated with the industry baseline conditions;
- Section 3 estimates the cost impacts of water pollution control equipment
- Section 4 projects the cost impacts of air pollution control equipment;
- Section 5 summarizes the cost impacts of environmental regulations and relates them to the industry baseline;
- Section 6 analyzes the revenue requirements and price effects associated with these cost impacts;
- Section 7 delineates the external financing needs which follow from these cost impacts;
- Section 8 describes other effects of these environmental regulations; and
- Section 9 details the economic impacts associated with the Phase II Effluent Guidelines.

Table 1

SHORT-RUN ECONOMIC IMPACT OF ENVIRONMENTAL REGULATIONS

1975-1977

(billions of 1975 dollars unless otherwise specified)

	Capital Expenditures		External Financing		Operations & Maintenance		Revenue Requirements		Average 1977 Price	
	Amount	Percent of Baseline (%)	Amount	Percent of Baseline (%)	Amount	Percent of Baseline (%)	Amount	Percent of Baseline (%)	Amount (dollars)	Percent of Baseline (%)
Industry Baseline Conditions										
Iron and Steel Production	$8.72	100.0	$3.74	99.2	$77.27	98.8	$94.87	98.7	$341.17	98.8
Water PCE In Place	-	-	0.04	1.1	0.68	0.9	0.93	1.0	3.12	0.9
Air PCE In Place	-	-	(0.01)	(0.3)	0.22	0.3	0.32	0.3	0.99	0.3
Total Baseline Conditions	$8.72	100.0	$3.77	100.0	$78.17	100.0	$96.11	100.0	$345.28	100.0
Water PCE Additions										
Phase I Processes	$0.25	2.9	$0.24	6.4	$0.03	*	$0.11	0.1	$0.56	0.2
Phase II Processes	1.33	15.3	1.18	31.3	0.13	0.2	0.53	0.6	2.46	0.7
Storm Runoff Guideline	0.02	0.2	0.02	0.5	-	-	**	-	0.02	*
Other Water PCE	0.16	1.8	0.15	4.0	0.03	*	0.07	0.1	0.38	0.1
Total Water PCE Additions	$1.76	20.2	$1.59	42.2	$0.19	0.2	$0.73	0.8	$3.42	1.0
Air PCE Additions										
Stack Emissions	$1.33	15.3	$1.16	30.8	$0.19	0.2	$0.69	0.7	$2.98	0.9
Fugitives Emissions	0.63	7.2	0.62	16.4	-	-	0.10	0.1	0.54	0.2
Other Air PCE	0.13	1.5	0.12	3.2	0.02	*	0.07	0.1	0.30	0.1
Total Air PCE Additions	$2.09	24.0	$1.90	50.4	$0.21	0.3	$0.86	0.9	$3.82	1.2
Grand Total	$12.56	144.0	$7.26	192.6	$78.56	100.5	$97.69	101.6	$352.52	102.1

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*Less than 0.05 percent

**Less than $5 million

Table 2

LONG-RUN ECONOMIC IMPACT OF ENVIRONMENTAL REGULATIONS

1975-1983

(billions of 1975 dollars unless otherwise specified)

	Capital Expenditures		External Financing		Operations & Maintenance		Revenue Requirements		Average 1983 Price	
	Amount	Percent of Baseline (%)	Amount	Percent of Baseline (%)	Amount	Percent of Baseline (%)	Amount	Percent of Baseline (%)	Amount (dollars)	Percent of Baseline (%)
Industry Baseline Conditions										
Iron and Steel Production	$27.50	100.0	$13.23	101.8	$279.91	99.0	$334.95	98.9	$361.96	99.1
Water PCE In Place	-	-	(0.15)	(1.2)	2.29	0.8	2.80	0.9	2.57	0.7
Air PCE In Place	-	-	(0.09)	(0.7)	0.67	0.2	0.85	0.3	0.68	0.2
Total Baseline Conditions	$27.50	100.0	$12.99	100.0	$282.87	100.0	$338.61	100.0	$365.21	100.0
Water PCE Additions										
Phase I Processes	$0.65	2.4	$0.48	3.7	$0.45	0.2	$0.98	0.3	$1.76	0.5
Phase II Processes	2.18	7.9	1.39	10.7	1.14	0.4	3.25	1.0	4.22	1.2
Storm Runoff Guideline	0.15	0.5	0.12	0.9	0.10	*	0.20	0.1	0.53	0.1
Other Water PCE	0.60	2.2	0.49	3.8	0.85	0.3	1.32	0.4	3.09	0.8
Total Water PCE Additions	$3.58	13.0	$2.49	19.2	$2.54	0.9	$5.75	1.7	$9.60	2.6
Air PCE Additions										
Stack Emissions	$1.65	6.0	$0.93	7.2	$0.96	0.3	$2.78	0.8	$2.70	0.7
Fugitives Emissions	1.34	4.9	0.95	7.3	1.15	0.4	2.44	0.7	3.70	1.0
Other Air PCE	0.26	0.9	0.18	1.4	0.22	0.1	0.47	0.1	0.75	0.2
Total Air PCE Additions	$3.25	11.8	$2.06	15.9	$2.34	0.8	$5.68	1.7	$7.15	2.0
Grand Total	$34.32	124.8	$17.54	135.0	$287.74	101.7	$350.04	103.4	$381.96	104.6

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*Less than 0.05 percent

I. INTRODUCTION

This report culminates a fifteen-month effort by Temple, Barker & Sloane, Inc. (TBS) to evaluate the economic impact of environmental regulations on the steel industry for the Office of Planning and Evaluation, Environmental Protection Agency (EPA). Its objectives are two-fold: (1) to provide both public policy-makers and industry representatives with an independent, in-depth evaluation of the total economic impact of environmental regulations within the context of the uncertainties facing the steel industry during the next decade, and (2) to assess the impact of the Federal Water Pollution Control Act Amendments of 1972.

The economic and regulatory climate in which the steel industry operates has undergone drastic changes since this study was initiated. Record profits within the steel industry were achieved in 1974 and the industry was looking forward with optimism. The economic recession from which the United States now appears to have recovered was devastating in its effect upon the steel industry. Shipments declined by more than 25 percent during 1975, but by year-end the industry was once again looking forward with optimism--tempered by the economic realities of an uncertain economy, foreign competition, and continued government regulation.

The relaxation of steel price controls during 1974 was a major factor in the industry's record performance that year. Perhaps just as important was the anticipation of shortages in basic raw materials which led to a significant increase in steel product inventories held by steel customers. The year 1975 was marked by direct confrontation between the

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Council on Wage and Price Stability (CWPS) and the steel industry over price increases. The CWPS Steel Symposium was convened in December to discuss in public forum the major differences of opinion evident among public policy-makers, industry spokesmen, knowledgeable industry observers and representatives of major steel consumers.

It is hoped that this report will further assist in promoting open discussion of public policy as it impacts the steel industry and will extend this dialogue to include the economic impact of environmental regulations.

REPORT COVERAGE

In analyzing the steel industry, EPA necessarily had to define the boundaries of its analysis. In so doing, EPA chose as its definition of the steel industry those on-site facilities from raw materials storage yards for coke oven and blast furnaces through finishing mills.[1] Thus facilities for mining, beneficiation and transportation of raw materials to the site of coking and/or ironmaking as well as fabrication facilities are excluded, but facilities used by the steel industry to produce pig iron for foundries and other uses are included. In addition, all other non-steel operations by steel firms have been excluded from the impact analysis reported herein.

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[1] *Utilizing data provided by AISI, it is estimated that steel operations as defined herein represented somewhat in excess of 70 percent of the net fixed assets of the major integrated steel companies during the 1972-1974 period. If iron ore, metallurgical coal and scrap metal were transferred at market values, sales revenues from steel operations approximated 80 percent of the total revenues of these firms during this period.*

The American Iron and Steel Institute (AISI), whose members operate 139 steel plants, provided detailed operating data on 130 of these plants for its cost impact study conducted by Arthur D. Little (ADL).[2] In order to utilize these data most effectively, TBS limited its analysis to steelmaking and finishing facilities which produce approximately 93 percent of domestic steel shipments. While extrapolation to total steel operations could be made, extension of the analysis to iron ore and coal mining, beneficiation, transportation, fabrication and other non-steel operations by steel companies would not be advised.

RESEARCH METHODOLOGY

To our knowledge this study of the steel industry is unique in its approach--combining the cost impact methodology employed by ADL in its study for the AISI and developing, for the first time, a computer-based revenue requirement and external financing methodology which permits an integrated analysis of the economic impacts of environmental regulations within the context of uncertain operating conditions.[3]

As the foundation for this study, TBS has developed a Policy-Testing model of the steel industry, hereinafter referred to as PTm(Steel). This computer-based model combines the planning assumptions of industry and technical experts

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[2] *Steel and the Environment: A Cost Impact Analysis*, Arthur D. Little for the American Iron and Steel Institute, May 1975.

[3] *In its report ADL concluded, "Several attempts have already been made to examine the economic impact of pollution control costs on the iron and steel industry. These have been severely limited by the lack of the kind of data now provided by this (i.e., ADL) study. An economic impact analysis, the next step after this cost impact examination, is needed to evaluate the full implications of pollution control costs for the iron and steel industry." (Ibid, p. VI-60)*

with the structural relationships utilized by engineers and accountants. Underlying PTm(Steel) are three independent modules which correspond to (1) production facilities planning and operations, (2) pollution control equipment planning and operations, and (3) revenue requirements and external financing needs determination. The first two modules provide the cost impacts which, when combined with the revenue requirements module, permit an integrated statement of the economic impact of environmental regulations.

All financial transactions within PTm(Steel) are computed in current dollars. During periods of inflation, these financial transactions recognize cost escalation where relevant (e.g., operations and maintenance expenses) as well as an historic cost basis (e.g., depreciation). However, for purposes of comparability, all financial data have been reported in constant 1975 dollars. In so doing, transactions have been inflated at sectoral rates of inflation and deflated by the rate of overall inflation (i.e., GNP deflator).[4]

The economic impact analysis reported herein focuses upon the 1975-1983 time period. In order to capture the cumulative effect of environmental regulations during this period, most exhibits provide detailed information for the three-year periods 1975-1977, 1978-1980 and 1981-1983 as well as the

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[4] *For example, assume that a rolling mill completed in 1975 costs $100.0 million. A comparable facility scheduled for initial operation in 1980 would cost $161.1 million in current dollars and $126.2 million in constant 1975 dollars* ***if*** *the sectoral rate of inflation in the construction industry were* ***10*** *percent and overall GNP inflation were 5 percent during the 1976-1980 period.*

1975-1983 period. The text and the tables therein summarize these data into short-run (1975-1977) and long-run (1975-1983) time periods.

In comparing the ADL methodology with PTm(Steel), it should be noted that the ADL computer-based model is capable of computing the cost impacts on a process, plant and/or company basis. The methodology utilized by TBS is consistent with these levels of analysis; however, the data provided TBS by ADL with the concurrence of AISI do not permit analyses at either the plant or company level. The AISI data were aggregated prior to their dissemination to TBS and others in order to avoid divulging proprietary operating data. When more detailed data become available, analyses at the plant and/or company level can be undertaken. However, these data were not required to perform the economic impact analysis herein reported.

2. INDUSTRY BASELINE CONDITIONS

In order to discuss the economic impact of the proposed and interim final effluent limitation guidelines and other pending environmental regulations on the steel industry, it is important first to establish a point of reference from which comparisons can be made. In so doing, the uncertainties inherent in forecasting conditions within the steel industry which are unrelated to environmental regulations should be segmented from those associated with these regulations. This reference point requires the establishment of a baseline set of conditions which represents anticipated future operating conditions, which excludes the impact of all pending environmental regulations--promulgated, proposed, and anticipated,[1] and which includes the impact of pollution control equipment placed into service prior to 1975.

The major steps undertaken to establish this industry baseline include:

- specifying future domestic steel shipments,
- determining capacity expansion requirements,
- projecting capital expenditures for capacity expansion and modernization,

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[1] *Environmental requirements analyzed herein are limited to those promulgated, proposed and anticipated by EPA. Thus they do not include regulations initiated by other federal agencies; for example, OSHA requirements. In addition, the engineering cost estimates and compliance schedules are based upon compliance by the steel firm at the plant site, not by municipal wastewater treatment facilities.*

- determining the level of capital expenditures for pollution control equipment placed into service prior to 1975,
- estimating operations and maintenance expenses associated with the above-mentioned production requirements and operation of pollution control equipment,
- projecting the revenues required to cover operating expenses and capital-related charges, and
- determining external financing needs.

The remainder of this section will detail the first five steps in this process of specifying an industry baseline. The last two steps will be discussed in Sections 6 and 7 after computing all of the cost impacts, including those associated with environmental regulations.

STEEL SHIPMENTS

Perhaps the most uncertain element in this baseline set of conditions is forecasting the future level of domestic steel shipments. Following a steady rate of growth during the early 1960s, domestic steel shipments remained relatively stagnant near 90 million tons from 1965 through 1972 as steel imports increased 70 percent. Record levels for domestic shipments, averaging 110 million tons per year, occurred in 1973 and 1974. Preliminary estimates of shipments during 1975 indicate a decline of approximately 25 percent from the 1974 level.

In establishing a baseline forecast for the steel industry, TBS has assumed that domestic steel shipments will rebound from the recession conditions evident in 1975 to the long-run trend by 1977 and continue to follow the long-run trend through 1983. This forecast, summarized in Exhibit 1, projects an annual growth in total domestic shipments of 2.54 million tons per year from 1977 onward and results in total domestic steel shipments of 113.0 million tons in 1977, 120.6 million tons in 1980, and 128.2 million tons in 1983.[2]

Recognizing that the capital expenditures for capacity expansion and modernization associated with any prespecified level for future domestic steel shipments would be highly problematic, TBS also specified both an optimistic and pessimistic level of shipments which deviated in the long run from baseline levels by plus and minus 10 percent, respectively. In selecting these alternative rates for growth in steel shipments, it should be noted that recent forecasts of 1980 shipments by AISI, the International Iron and Steel Institute, Arthur D. Little (for the AISI), Booz, Allen & Hamilton (in separate studies for the Council on Environmental Quality and the Department of Commerce), Chase Econometrics, Data Resources, Inc., and the Bureau of Labor Statistics differ from the baseline forecast by less than 7 percent.

CAPACITY EXPANSION

The forecast baseline growth in steel shipments implies a need for capacity expansion. In analyzing this need, TBS assumed that the steel industry will expand its capacity to meet anticipated steel shipment requirements and to be able to operate at planned levels of utilization.[3]

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[2] *The analysis reported herein is limited to steelmaking and finishing facilities which represent 93 percent of domestic shipments. Thus the corresponding baseline forecast of shipments would be 105.1 million tons in 1977, 112.2 million tons in 1980 and 119.2 million tons in 1983.*

Capacity additions to basic oxygen and electric furnaces of approximately 50 million tons will be required to meet the baseline shipments forecast and to replace open hearth capacity being retired. These additions imply a net increase in steelmaking capacity of approximately 25 million tons, necessitating the expansion of coal, scrap and coking facilities and the replacement of approximately 10 million tons of ironmaking capacity in the form of old blast furnaces which are currently not in blast. The transition toward continuous casting will require the addition of continuous casting facilities capable of producing nearly 30 million tons. Most finishing mills--especially wire, pipe and tubing, galvanizing and tin plating, and plate--will require additional capacity to meet the baseline requirements.

During the 1973-1974 period, many steelmaking and finishing processes operated at levels above their sustainable utilization. If shipments return to the long-run trend by 1977, a substantial amount of the steelmaking, continuous casting and finishing expansion will be needed in the short run.

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[3] *It should be noted that this approach assumes that the industry, as well as each firm within the industry, will add facilities to achieve balances in terms of annual throughput. Given the importance of maintaining market share and the economies of scale evident in several processes, this approach projects the minimum capital expenditures required to meet a specified projection of domestic steel shipments.*

CAPITAL EXPENDITURES FOR EXPANSION AND MODERNIZATION

The capital expenditures implied by the above-mentioned schedule of capacity additions are as follows:

CAPITAL EXPENDITURES FOR EXPANSION AND MODERNIZATION
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Capacity Expansion		
Placed Into Service	$3.33	$ 9.61
Changes in Construction Work in Progress	0.40	2.01
TOTAL	$3.73	$11.62
Capacity Modernization	4.99	15.89
GRAND TOTAL	$8.72	$27.50

These capital expenditures for capacity expansion and modernization are detailed by stage of production and by time period in Exhibits 2 and 3, respectively.[4]

Expenditures for the expansion of production capacity amount to $3.7 billion in the short run and $11.6 billion in the long run--approximately $1.3 billion per year, and include both equipment placed into service during the period and changes in the amount under construction. In the long run these expenditures for increases in construction work in progress (CWIP) exceed $2.0 billion, an amount ignored in most studies of the steel industry.

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[4] *TBS has segmented steel production into 28 processes. These processes are then summarized into five stages of production--on-site raw materials preparation, ironmaking, steelmaking, casting and forming, and finishing. Exhibit 4 provides a schematic diagram of the steel production process.*

The TBS approach to estimating capital expenditures for capacity expansion, which focuses on production requirements and capacity additions by process, differs significantly from the methods employed by other industry observers. Other estimates of expansion requirements focus on overall steelmaking facilities which, when combined with a rough estimate of the cost of adding a ton of raw steel capacity (ranging from $200 to more than $800 per ton), permits an estimate of capital expenditures for expansion. Furthermore, estimates of additions to steelmaking capacity are often confounded by an unspecified conversion from open hearth to basic oxygen and electric furnace production.

In addition to capital expenditures for capacity expansion, outlays for modernization of existing capacity represent a relatively constant flow of funds which usually cannot be delayed or curtailed without operating inefficiencies and/or loss of productive capacity. These expenditures for reworking and/or replacing existing facilities do not result in increased capacity. They amount to $5.0 billion in the short run and $15.9 billion in the long run and comprise 57 percent of baseline capital expenditures.

AISI estimates expenditures for capacity modernization by focusing upon the aggregate level of capital expenditures during the past decade when productive capacity remained relatively unchanged.[5] The TBS methodology permits more detailed analysis than the approaches used by AISI and other industry observers. Utilizing AISI data provided by ADL, TBS estimated annual capital expenditures required to maintain a ton of existing capacity for each process.[6] These annual expenditures, prior to adjustment for cost escalation, ranged from 1.0 to 6.8 percent of the original construction cost.

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[5] *Steel Industry Economics and Federal Income Tax Policy*, American Iron and Steel Institute, June 1975.

The TBS methodology for computing capital expenditures for modernization yields estimates comparable to those developed by other observers. For example, AISI has reported that total capital expenditures by the steel industry during the last decade have averaged $1.8 billion per year. The TBS estimate of capital expenditures for the modernization of steel operations during the 1975-1983 period is $1.8 billion per year.[7]

CAPITAL EXPENDITURES FOR POLLUTION CONTROL EQUIPMENT IN SERVICE

In specifying industry baseline conditions, TBS included the impact of pollution control equipment which was placed into service prior to 1975. The impact of in-place pollution control equipment includes past capital expenditures which must be recovered as well as the annual operations and maintenance expenses which are incurred. These past capital expenditures will result in depreciation and other capital charges during the next decade.

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[6] *This method of computing capital expenditures for modernization and reworks was suggested, although not employed, by ADL in its study for AISI. Instead, ADL utilized the AISI approach to estimate these expenditures.*

[7] *It should be noted that the TBS estimate is in constant 1975 dollars and covers only 93 percent of the steel industry. The AISI concludes, "...it is estimated that capital expenditures to maintain present capacity during the 1975-1983 period will approximate at least $2.0 billion per year before escalation." (op. cit., p.24). Thus, TBS expenditures for reworks and modernization approximate those proposed by the AISI.*

As a basis for determining the impact of these environmental facilities, EPA technical contractors estimated by process the proportion of existing facilities which have installed equipment necessary for compliance with each of the water effluent guidelines and air emission standards. Utilizing these proportions, TBS estimated capital expenditures incurred prior to 1975 for pollution control facilities to be nearly $2.2 billion--$1.5 billion for water and $0.7 billion for air pollution control equipment.

OPERATIONS AND MAINTENANCE EXPENSES[8]

PTm(Steel) computes production requirements for each process which are consistent with the previously cited baseline forecast of steel shipments. When these production requirements are combined with factor prices for each resource employed, operations and maintenance (O&M) expenses during the 1975-1983 period are as follows:

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[8] *Operations and maintenance expenses for iron and steel production as defined herein include direct labor and overhead, raw materials, energy, supplies and other utilities, but exclude depreciation and other capital charges.*

OPERATIONS AND MAINTENANCE EXPENSES FOR IRON AND STEEL PRODUCTION
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Basic Raw Materials	$37.29	$140.65
Direct Labor and Overhead	28.44	99.93
Other O&M Costs	11.54	39.33
TOTAL	$77.27	$279.91

These O&M expenses for iron and steel production are detailed by stage of production and by time period in Exhibit 5.

Operations and maintenance expenses represent the largest component of steel industry costs. These expenses, which are expected to average $25.8 billion per year in the short run and $31.1 billion in the long run, are dominated by basic raw material costs and labor-related charges. The remainder of O&M expenses can be accounted for by other raw materials (e.g., fluxes and alloying elements), energy in the form of natural gas, fuel oil and electricity, and miscellaneous maintenance supplies and utilities.

Basic raw materials represent the largest and fastest growing component of O&M expenses--38 percent of O&M expenses in 1972, 48 percent in the short run and 50 percent in the long run. In projecting iron ore and metallurgical coal prices, TBS has assumed that the recent decline in productivity within underground coal mines will continue during the next decade and that future wage increases of miners will parallel those of steelworkers. Furthermore, it is anticipated that the cost per ton of hot metal and scrap metal charges to steelmaking furnaces will be comparable.[9]

Direct labor and related overhead charges are assumed to escalate at a rate in excess of inflation within the economy in general. However, the significant increase in raw material prices results in a relative decline in labor's share of O&M expenses from 43 percent in 1972 to 37 percent in the short run and 36 percent in the long run.

In addition to these O&M expenses for iron and steel production, operation of pollution control equipment placed into service prior to 1975 will require expenses totalling $3.9 billion during the 1975-1983 period as follows:

OPERATIONS AND MAINTENANCE EXPENSES FOR POLLUTION CONTROL EQUIPMENT PLACED INTO SERVICE PRIOR TO 1975

(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Water Pollution	$0.68	$2.29
Air Pollution	0.22	0.67
TOTAL	$0.89	$2.96

Exhibits 6 and 7 detail these O&M expenses by stage of production and by time period for water and air pollution control equipment, respectively.

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[9] *These assumptions imply basic raw material costs (in nominal terms) of $27.32, $46.35 and $100.72 per ton in 1977 and $38.86, $84.60 and $158.67 per ton in 1983 for iron ore, metallurgical coal and scrap metal, respectively.*

These operating expenses are estimated to be $0.3 billion per year in the short run and approximately 10 percent higher in the long run. More than 75 percent of the O&M expenses associated with pollution control equipment placed into service prior to 1975 will be required to operate water pollution control equipment with the remainder associated with air pollution control.

Throughout subsequent analyses of environmental regulations, these impacts from existing equipment will be segmented from those associated with pollution control equipment additions required to meet environmental regulations promulgated, proposed, and anticipated.

3. COST IMPACT OF FEDERAL WATER POLLUTION CONTROL ACT AND OTHER WATER POLLUTION REGULATIONS[1]

The Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500, hereinafter referenced as the Water Act) constitute the current statutory basis of regulatory responsibility in the area of effluent standards. The national objective declared by this environmental legislation is to eliminate discharges of pollutants into navigable waters by 1985. As an interim goal, waters are to be suitable for the purposes of human recreations and the growth of fish, shellfish, and other wildlife by July 1, 1983. The Water Act stipulated the goal of improving receiving water quality by cleaning up industrial process discharges with means which are both technologically and economically feasible.

The Water Act charged EPA with the responsibility of developing limitations guidelines for point sources of effluents. In addition, authority for discharge permit programs was transferred from the U.S. Army Corps of Engineers, with whom it had traditionally rested, to the EPA.

Section 301(b) of the Water Act specifies limitation standards based on the application of Best Practicable Control Technology Currently Available (BPCTCA) which are to be operational in all existing steel industry facilities by July 1, 1977. The industry is expected to meet a higher standard of water effluent control in existing facilities by July 1, 1983 based on the application of Best Available

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[1] *This section provides the overall cost impact of the Federal Water Pollution Control Act, including those environmental regulations promulgated, pending and anticipated. Section 9 details the economic impact of the Phase II guidelines as published in the March 29, 1976 Federal Register.*

Technology Economically Achievable (BATEA) which will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants.

The Water Act further requires EPA to establish a set of effluent standards known as New Source Performance Standards (NSPS) to regulate new facilities on which construction is begun after the publication of the proposed NSPS effluent guidelines. Performance standards at such new sources are to reflect the greatest degree of effluent reduction achievable through the application of the Best Available Demonstrated Control Technology (BADCT) which, were practicable, affords a standard permitting no discharge of pollutants.

Given the statutory requirements laid out in the Water Act, EPA contracted with the Cyrus Rice Division of NUS Corporation (NUS/Rice) to conduct an extensive engineering study of the steel industry to develop effluent limitations guidelines. For purposes of that analysis, the operations of the industry were divided into two parts: raw steelmaking processes and hot forming/cold finishing processes.

The first segment of the NUS/Rice study, which covered steelmaking operations from raw material preparation through continuous casting of steel, is referred to as the Phase I document. The standards were published in the June 28, 1974 Federal Register.[2]

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[2] *EPA-440/1-74-024-a, Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Steelmaking Segment of the Iron and Steel Manufacturing Point Source Category, June 1974.*

Subsequently, the Phase I guidelines came under judicial review in court cases instituted by the AISI and several steel companies. The resulting decision handed down in November 1975, by the U.S. Court of Appeals, Third Circuit, remanded the guidelines for review of certain sections by EPA. That review is underway.

A draft version of the second segment, referred to as Phase II operations, includes breaking of ingots into primary forms and other processes through finishing and coating processes. It was released by EPA in August 1975.[3] This Advanced Notice of Proposed Rulemaking (ANPR) documents was also published in the August 21, 1975 Federal Register but did not have the legal standing of proposed standards. A revised version of the Phase II guidelines was published in the March 29, 1976 Federal Register.[4]

The statutory date for achievement of BPCTCA is July 1, 1977. In many cases within the iron and steel industry this compliance date may not be achieved due to construction lead times which depend upon the specific situation at individual plants. The following analysis of the economic impact of the Water Act has been based upon an assumption that full compliance with BPCTCA requirements will occur sometime during the period between July 1, 1979 and July 1, 1981.

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[3] *EPA-440/1-75/048, Development Document for Advanced Notice of Proposed Rulemaking for Effluent Limitations Guidelines and New Source Performance Standards for the Hot Forming and Cold Finishing Segment of the Iron and Steel Manufacturing Point Source Category, August 1975.*

[4] *EPA-440/1-76/048-b, Development Document for Interim Final and Proposed Effluent Limitations Guidelines and New Source Performance Standards for Forming, Finishing and Specialty Steel Segments of the Iron and Steel Manufacturing Point Source Category, March 1976.*

The following analysis highlights the impacts of compliance by July 1, 1979. The implications of compliance by July 1, 1981 are presented at the end of this section.

COSTING METHODOLOGY

In projecting the cost impacts of the Water Act and other water pollution regulations, detailed engineering cost estimates developed for EPA by NUS/Rice on the basis of a model plant size were converted into capital cost and operating cost equations which recognize scale economies in the construction and operation of water pollution control equipment. In so doing, TBS translated the NUS/Rice engineering cost estimates to a basis directly comparable with similar estimates developed by ADL in its cost impact study for AISI.

The NUS/Rice engineering cost estimates, when combined with the AISI inventory of steel facilities by process and a schedule for compliance with BPCTCA, BATEA, NSPS and other guidelines, permit a detailed analysis of the cost impacts associated with the Water Act. These cost impacts are then analyzed within the context of the previously cited industry baseline conditions to determine the economic impacts of environmental regulations.

CAPITAL EXPENDITURES FOR WATER POLLUTION CONTROL EQUIPMENT

Capital expenditures for water pollution control equipment expected to be placed into service during the 1975-1983 period to meet the requirements of the Water Act and other water regulations are estimated as follows:

CAPITAL EXPENDITURES FOR
WATER POLLUTION CONTROL EQUIPMENT
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Phase I Processes	$0.25	$0.65
Phase II Processes	1.33	2.18
TOTAL	$1.58	$2.83
Storm Runoff	0.02	0.15
Other Water	0.16	0.60
GRAND TOTAL	$1.76	$3.58

These capital expenditures are detailed by stage of production and by time period or by effluent guideline in Exhibits 8 and 9, respectively.

Of the $3.6 billion in capital expenditures for water pollution control equipment required in the long-run period (1975-1983), nearly one-half will be expended during the short-run period (1975-1977). By far the largest component of these capital outlays is required to meet the anticipated Phase II effluent guideline which represents 75 percent of the short-run and 60 percent of the long-run requirements.

The long-run relationship between capital expenditures for process equipment to meet effluent guidelines and expenditures for capacity additions can be approximated by comparing NSPS costs to outlays for capacity expansion during the same time period. Using the mix of capacity additions during the 1981-1983 period, this long-run impact is estimated to be less than 4 percent.

Since capital expenditures herein defined include increases in construction work in progress, short-run requirements include cash payments for pollution control equipment to be placed into service after 1977. In fact, exactly one-half of the short-run capital expenditures represent outlays for construction work in progress. In the long run, expenditures for increases in construction work in progress comprise 10 percent of total outlays during the 1975-1983 period.

OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT

Operations and maintenance expenses associated with operating water pollution control equipment placed into service during the 1975-1983 period are projected as follows:

OPERATIONS AND MAINTENANCE EXPENSES FOR
WATER POLLUTION CONTROL EQUIPMENT
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Phase I Processes	$0.03	$0.45
Phase II Processes	0.13	1.14
TOTAL	$0.16	$1.59
Storm Runoff	--	$0.10
Other Water	0.03	0.85
GRAND TOTAL	$0.19	$2.54

Total O&M expenses are detailed by stage of production and by time period or by effluent guideline in Exhibits 10 and 11, respectively. It should be noted that these exhibits include O&M expenses associated with water pollution control equipment placed into service prior to 1975. The above table represents only the difference between total O&M expenses and those expenses for equipment already placed into service. O&M expenses for water pollution control equipment placed into service prior to 1975 were detailed in Exhibit 6.[5]

The operations and maintenance expenses associated with water pollution control facilities expected to be installed within the 1975-1977 period amount to less than $0.2 billion in the short run. These short-run O&M expenses are overshadowed by the $0.7 billion required to operate the equipment placed into service prior to 1975. In the long run, the additions to water pollution control equipment represent $2.5 billion, more than 50 percent of the $4.8 billion required to operate water pollution control equipment. By 1983, water pollution control equipment placed into service during the 1975-1983 period will increase annual O&M expenses by more than $0.6 billion.

By far the largest component of these additional operating expenses is that linked to the operation of water pollution control equipment on steel finishing mills. These O&M expenses exceed $1.0 billion during the 1975-1983 period and represent 65 percent of the operating costs for process-related equipment. Another major component is associated with other water regulations, including equipment required to control thermal, non-contact cooling, utility area, and other wastewater discharges not covered by either Phase I or Phase II effluent guidelines.

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[5] *It should be noted that O&M expenses comprise cumulative expenditures during the period. Since the amount of pollution control equipment installed increases in each year, no simple average will determine the impact of pollution control relative to production expenses.*

COMPARISON OF ALTERNATIVE ENGINEERING COST ESTIMATES FOR WATER POLLUTION CONTROL EQUIPMENT

No cost impact analysis of the steel industry can ignore the ADL study for the AISI which represents, in our opinion, the first comprehensive evaluation of the capital expenditures and operating costs associated with environmental regulations. For this reason PIm(Steel) has been designed to accept alternative engineering cost estimates, including those provided by ADL.

At first glance, the above-mentioned capital expenditures for process-related water pollution control equipment appear to be quite comparable to those published by ADL if capital expenditures for replacement facilities are excluded.[6] ADL estimates capital expenditures for water pollution control to be $3.5 billion for existing facilities and $0.9 billion for new facilities based on a pro rata share of total expenditures for new facilities. Utilizing NUS/Cyrus Rice engineering cost estimates, comparable TBS estimates of capital expenditures totaled $4.3 billion--$1.5 billion for pollution control equipment placed into service prior to 1975 and $2.8 billion for additional facilities required to meet the requirements of the Water Act.[7]

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[6] *One-half of the ADL $4.9 billion estimate of capital expenditures for pollution control on new facilities represented replacement facilities; that is, new capacity which replaces existing capacity being retired.*

[7] *An estimate of initial capital investment based upon the NUS/Cyrus Rice costing methodology and engineering cost estimates, as reported in Table 79 of the Phase I Document and in Table 197 of the Phase II Document, would be $2.4 billion in 1975 dollars. This differs significantly from the comparable estimate utilizing the TBS methodology and NUS/Cyrus Rice*

However, these estimates are not directly comparable since they differ in the underlying forecasts of steel shipments, in the adjustment for commingling of wastestreams, in the computation of expenditures for in-place facilities, and in the inclusion of construction work in progress. After these adjustments are made to place the capital expenditures on a comparable basis, the ADL estimate of additional expenditures during the 1975-1983 period exceeds the TBS estimate by $0.9--$3.4 vs. $2.5 billion. Exhibit 12 provides a detailed comparison of these alternative estimates of capital expenditures.

A close process-by-process comparison of cost impacts indicates significant differences for coke ovens and blast furnaces. In addition, differences in the engineering cost estimates for finishing mills can be explained partially by the more stringent Phase II guidelines analyzed by NUS/Rice.

The above summary of capital expenditures excludes the ADL estimate of requirements for replacement facilities. ADL estimated that $0.9 billion would be required to bring replacement facilities into compliance with the effluent guidelines. Such an estimate could be consistent with the ADL methodology wherein an estimate of capital expenditures for pollution control equipment placed into service prior to 1975 was based upon actual industry expenditures without consideration of whether the equipment in place is in compliance with the effluent guidelines.

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engineering cost estimates for four reasons; in order of importance: (1) the TBS estimate is based upon 1983 capacity, the NUS/Cyrus Rice estimate upon 1972 production levels; (2) the TBS estimate recognizes economies of scale, the NUS/Cyrus Rice estimate does not; (3) the TBS estimate includes construction work in progress, the NUS/Cyrus Rice estimate does not; and (4) the TBS estimate utilizes the AISI inventory of 1972 capacity and the baseline forecast of domestic shipments, the NUS/Cyrus Rice estimate employs their own inventory of process units.

On the other hand, these expenditures for replacement facilities are inconsistent with the TBS methodology which bases expenditures for equipment in place upon the NUS/Cyrus Rice estimate of the proportion of existing facilities which are in compliance with the BPCTCA and BATEA requirements. Using this approach, it would be unlikely that a steel company would bring an existing facility into compliance only to retire or replace that facility during the 1975-1983 period.

Exhibit 13 provides a detailed comparison of operations and maintenance expenses based upon NUS/Cyrus Rice and ADL engineering cost estimates. Once again, significant differences were found between the estimates for coke ovens and blast furnaces.

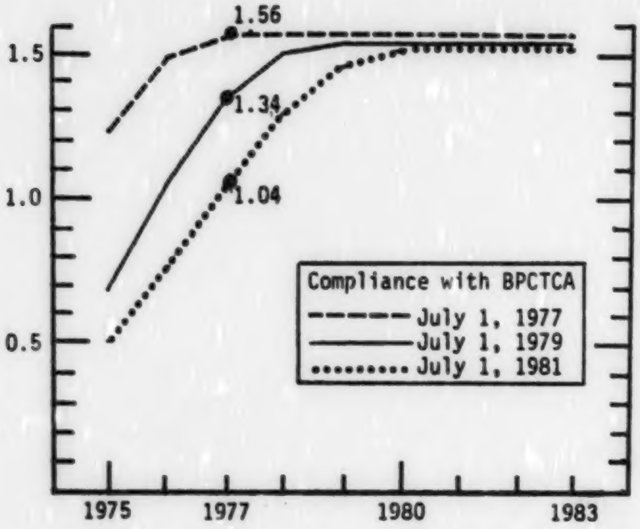
Another area of significant difference in engineering cost estimates is the storm runoff guideline--the ADL estimate of capital expenditures ranges from $0.8 to $2.8 billion; whereas , the estimate based upon NUS/Cyrus Rice engineering costs is only $0.15 billion. This difference emanates from two basic sources. First, ADL assumed that the runoffs from the entire plant site must be contained and treated. The Phase II guideline requires containment and treatment from only coal, ore and stone piles. Second, there are major differences in the engineering assumptions regarding the magnitude of the storm for which facilities would be designed.

SENSITIVITY ANALYSIS:
BPCTCA COMPLIANCE SCHEDULE

While the statutory compliance schedule for the BPCTCA guideline is July 1, 1977, the previous analysis has been based upon a compliance schedule wherein all facilities achieve BPCTCA requirements by July 1, 1979. TBS has also analyzed the impact of full BPCTCA compliance by July 1, 1981 as well as the statutory date of July 1, 1977.

The annual stream of capital expenditures during the 1975-1983 period for these alternative schedules is as follows:

CUMULATIVE CAPITAL EXPENDITURES FOR
ALTERNATIVE BPCTCA COMPLIANCE DATES
(billions of 1975 dollars)



In the long run, total capital expenditures differ marginally as a result of timing differences in cash outlays.

As might be expected, however, compliance dates significantly impact the short-run capital expenditures. Full BPCTCA compliance by 1977 requires short-run capital expenditures of $1.6 billion. However, since full compliance is not expected until sometime between July 1979 and July 1981, actual short-run capital expenditures are expected to be between $1.1 and $1.3 billion.

The external financing implications of these alternative compliance schedules are analyzed in Section 7 of this report.

4. COST IMPACT OF CLEAN AIR ACT AND OTHER AIR POLLUTION REGULATIONS

The Clean Air Act of 1970 (P.L. 91-604, hereinafter referenced as the Air Act), establishes authority and regulatory responsibility in the area of emission standards. The Air Act's objectives are protection of public health and welfare. For stationary point sources, such as steel industry facilities, direct responsibility lies with the states. EPA designates pollutants to be controlled and approves state initiated implementation plans. Implementation is to be accomplished in two stages--improvement to Primary Air Quality Standards by July 1, 1975 and to Secondary Air Quality Standards as soon as possible thereafter.

Each state must develop implementation plans to achieve, maintain, and enforce the emission standards for existing sources. Most state plans were approved by 1972; however, several factors have combined to delay compliance in some areas. First, some states such as New York have delayed the date for compliance in their implementation plans. Second, federal courts have stayed portions of the implementation plans for some states (e.g., Ohio and Maryland). Third, portions of some implementation plans have not yet been approved by EPA. Finally, implementation has been delayed in some cases due to litigation by steel firms.

The statutory compliance date for Primary Air Quality Standards is July 1, 1975. Recognizing the abovementioned delays, the following analysis has been based upon compliance with the stack emission standard by July 1, 1978 and the fugitive emission standard by July 1, 1980.

New Source Performance Standards (NSPS) apply to all facilities where construction is begun after proposal of the NSPS standard. Emission standards for new sources are established by the EPA administrator. These standards must employ "the base system of emission reduction which (taking into account the cost of achieving such reduction) the Administrator determines has been adequately demonstrated." Though new source standards have been specified for some processes such as electric arc furnaces, standards for other processes may not be proposed for several years. New facilities constructed before proposal of new source standards must meet the same standards as existing sources.

COSTING METHODOLOGY

Due to the varying and complex standards set by individual states, no engineering cost analysis of compliance based upon equipment specified by each state has been performed. Available cost data are based on published reports regarding equipment which may exceed or fall short of the required standards. In the area of new source standards, states may supersede EPA standards with more stringent controls. Hence, as with the existing source costs, there is a lack of precise cost data for new source standards.

The 1974 Cost of Clean Air report prepared for EPA by Battelle Columbus Laboratories has been used as the basis for projecting cost impacts for stack emission standards.[1]

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[1] *Some engineering cost data reported in the 1974 Cost of Clean Air and used herein were obtained from A Systems Analysis of the Integrated Iron and Steel Industry, Battelle Columbus Laboratories, 1969.*

Unlike water pollution control costs which were based on a specific treatment model, Battelle cost estimates are based on published data for equipment with varying specifications.

Engineering cost estimates for equipment to meet fugitive emission standards were supplied by the EPA Standards and Cost Analysis Branch in Durham, North Carolina. These cost estimates relied upon ADL engineering cost equations and assumed EPA air flow rates.

Utilizing these cost equations, the AISI inventory of steel facilities by process and the schedule of compliance described above, TBS performed a detailed analysis of the cost impacts associated with the Air Act. These costs have been analyzed within the context of the previously described steel industry baseline conditions to determine the economic impact of environmental regulations.

CAPITAL EXPENDITURES FOR AIR POLLUTION CONTROL EQUIPMENT

Capital expenditures for air pollution control equipment during the period 1975 to 1983 are estimated as follows:

CAPITAL EXPENDITURES FOR
AIR POLLUTION CONTROL EQUIPMENT
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Stack Emissions	$1.33	$1.65
Fugitive Emissions	0.63	1.34
Other Air	0.13	0.26
TOTAL	$2.09	$3.25

These capital expenditures are detailed by stage of production and by time period or by emission standard in Exhibits 14 and 15, respectively.

Of the $3.2 billion of capital expenditures required for air pollution control equipment in the long run, nearly two-thirds will be expended during the 1975-1977 period. Requirements in the short run are disproportionately large due to related increases in construction work in progress. Nearly $1.1 billion of the $2.1 billion required in the short run represents increases in construction work in progress. Nearly two-thirds of the funds expended in the short run are required for stack emissions. Fugitive emissions account for 40 percent of capital expenditures in the long run.

OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT

Operations and maintenance expenses required to operate air pollution control equipment placed into service during the period 1975-1983 are summarized below:

OPERATIONS & MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Stack Emissions	$0.19	$0.96
Fugitive Emissions	-	1.15
Other Air	0.02	0.22
TOTAL	$0.21	$2.33

Total operations and maintenance expenses are tabulated by stage of production and by time period or by emission standard in Exhibits 16 and 17, respectively. These exhibits include O&M expenses for air pollution control equipment placed into service prior to 1975. The above table represents only O&M expenses for equipment placed into service during the 1975-1983 period. Expenses for air pollution control equipment installed prior to 1975 were detailed in Exhibit 7.

Operations and maintenance expenses of $0.4 billion in the short run are split nearly equally between in-place and new equipment. In the long run, only 22 percent of the $3.0 billion total for air pollution control is attributable to equipment placed into service prior to 1975. In 1983, when all air treatment facilities are in operation, O&M expenses for air pollution control facilities installed during the 1975-1983 period exceed $0.4 billion. On-site raw materials preparation represents nearly 50 percent of air pollution control costs. These costs are entirely attributable to sintering and coking.

COMPARISON OF ALTERNATIVE ENGINEERING COST ESTIMATES FOR AIR POLLUTION CONTROL EQUIPMENT

The ADL study represents the most recent and complete study of air pollution control costs done outside EPA. PTm(Steel) has, therefore, been designed to accept alternative engineering cost estimates, including those provided by ADL. ADL costs can be examined in a series of comparisons.

An initial comparison of capital expenditures and operations and maintenance expenses indicates significant differences in reported findings between ADL and this analysis. Capital expenditures estimated for air pollution control in this study are $3.9 billion which includes equipment installed prior to 1975. The comparable estimate from the ADL study is $6.9 billion, including a pro rata share of expenditures for new facilities, but excluding expenditures for replacement facilities.[2]

Capital expenditures estimated by including ADL engineering cost estimates within PTm(Steel) total $6.7 billion in the long run. Differences in the capital expenditures estimated in this manner and those reported by ADL reflect alternative assumptions regarding steel shipments and cost escalation factors.

Given the ability of PTm(Steel) to reproduce ADL costs, the results from PTm(Steel) with ADL engineering cost estimates can be compared to PTm(Steel) results utilizing Battelle Columbus Laboratories and EPA engineering cost estimates. When these estimates of capital expenditures are placed on a comparable basis, the ADL estimate for the 1975-1983 period is more than double the estimate based upon Battelle and EPA engineering cost assumptions--$6.7 billion vs. $3.3 billion. This comparison of air pollution control costs by stage of production is detailed in Exhibits 18 and 19.

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[2] *The alternative assumptions for replacement facilities have been discussed more fully in Section 3.*

More than 90 percent of the difference between ADL and EPA cost impacts, for both capital expenditures and operations and maintenance expenses, results from alternative assumptions for the control of fugitive emissions. While EPA engineering cost estimates are based upon the same cost relationships as ADL, EPA assumes that considerably lower air flows will be required to achieve fugitive emissions control and that approximately 65 percent of open hearth furnaces presently installed will not be treated for fugitive emissions due to closure. The bulk of the differences between cost impacts is associated with the steelmaking furnaces.

5. SUMMARY OF THE COST IMPACTS OF ENVIRONMENTAL REGULATIONS

The economic impact of environmental regulations can be summarized by focusing on five key indicators: capital expenditures, operations and maintenance expenses, external financing needs, revenue requirements, and average price levels. Of these, the first two have been considered independently for water and for air in the previous two sections. The combined cost of air and water pollution control in terms of capital expenditures and operations and maintenance expenses will be summarized in this section. From these combined costs, subsequent sections will evaluate the economic impact of environmental regulations in terms of the remaining indicators.

Expenditures for water and for air pollution control are additive to the baseline--that is, total expenditures are the sum of these two categories and the baseline.

CAPITAL EXPENDITURES

Capital expenditures for pollution control and baseline are combined as follows:

COMBINED CAPITAL EXPENDITURES FOR WATER AND AIR POLLUTION CONTROL EQUIPMENT WITH BASELINE REQUIREMENTS

(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Baseline	$8.72	$27.50
Pollution Control Equipment		
Water	1.78	3.58
Air	2.09	3.25
TOTAL	$3.85	$6.83
GRAND TOTAL	$12.56	$34.32
Pollution Control as Percent of Baseline	44.0%	24.8%

Capital expenditures for steel operations are expected to total $34.3 billion during the period 1975 to 1983, an average of $3.8 billion per year. The annual amount is somewhat higher in the near term and lower at the end of the period. This is a significant amount when compared to the $2.6 billion per year in constant 1975 dollars expended by the steel industry for all purposes during the last decade.

Air and water pollution control combined represents $6.8 billion in capital expenditures from 1975 to 1983. Over one-half, $3.8 billion, of this amount is required in the short run (1975-1977). Capital expenditures will be incurred at the rate of $1.3 billion per year for the remainder of the period. This bias toward early expenditures is caused by the need to meet compliance schedules and the associated increases in both equipment in service and construction work in progress. Over 50 percent of short-run capital expenditures are for increases in construction work in progress, while in the long run, this figure drops to 12 percent.

Capital expenditures for pollution control represent over 40 percent of total short-run needs and almost 25 percent of long-run needs. In the previous nine years, capital expenditures for pollution control equipment placed into service by the steel industry totaled $1.7 billion in constant 1975 dollars--only 7 percent of capital expenditures during this period.[1]

OPERATIONS AND MAINTENANCE EXPENSES

Combined operations and maintenance expenses for the baseline, water and air pollution control are tabulated below:

COMBINED OPERATIONS AND MAINTENANCE EXPENSES FOR WATER AND AIR POLLUTION CONTROL EQUIPMENT WITH BASELINE REQUIREMENTS

(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Baseline	$78.17	$282.87
Pollution Control Equipment		
Water	0.19	2.54
Air	0.21	2.33
TOTAL	$0.40	$4.87
GRAND TOTAL	$78.56	$287.74
Pollution Control as Percent of Baseline	0.5%	1.7%

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[1] *Steel Industry Economics and Federal Income Tax Policy, op.cit.*

O&M expenses are dominated by production costs. Of the $287.7 billion of O&M expenses incurred from 1975 to 1983, air and water pollution control combined represent only 1.7 percent. However, these cumulative amounts understate somewhat the long-run effect of pollution control O&M expenses since only part of the equipment is in operation throughout the period. In 1983, when all facilities are fully treated for required pollution control, pollution control additions during 1975-1983 represent 2.8 percent of total O&M expenses.

6. ECONOMIC IMPACT OF ENVIRONMENTAL REGULATIONS: REVENUE REQUIREMENTS AND PRICE EFFECTS

Thus far the impact of environmental regulations has been limited to the cost impacts associated with capital expenditures and operations and maintenance expenses. These cost impacts must be converted to revenue requirements, related price effects, and external financing needs in order to evaluate fully the economic impact of environmental regulations.

Most studies of the steel industry focus on the cost impacts of expansion, modernization and environmental regulations and their aggregate financing requirements by utilizing historic cash flows. Such an approach, while perhaps providing insight into future conditions within the industry, assumes that economic, regulatory and industry conditions in the recent past will be repeated in the near future. Given that the last five years have included periods of high inflation, limited capacity expansion, price controls, record shipments and profit levels, worldwide steel shortages, dollar devaluation (and revaluation), significant inventory accumulation (and depletion) and a deep recession, it is highly unlikely that events of a similar nature will be equally important during the 1975-1983 period.

The TBS methodology recognizes this uncertain economic and regulatory environment by focusing on revenue requirements, the application of funds to capital expenditures and other uses, internal cash flows, and the resulting external financing needs. Revenue requirements within PTm(Steel) are defined as the recovery of all costs, including a target rate of return on common equity. These costs include operating expenses, depreciation, sales and property taxes, interest income and expenses, federal and state income taxes, and net income requirements. Since some of these costs vary with economic and regulatory conditions, TBS has performed sensitivity analyses on key economic and financial parameters.[1] A schematic diagram of the revenue requirements module within PTm(Steel) is provided in Exhibit 20.

Once revenue requirements have been determined, an average price effect can be computed by dividing the abovementioned revenue requirements in any given year by domestic steel shipments.[2] Given the level of detail captured with PTm(Steel), these average price effects can be computed on an overall basis, by product, by stage of production, or by value-added at each process within the steel production process.

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[1] *Perhaps the most controversial revenue requirement is that associated with the target rate of return on common equity. In order to determine the impact of this key parameter, TBS analyzed rates of return equal to those historically observed for all manufacturing firms, for steel firms overall, and for steel operations by major steel companies. Baseline conditions include net income requirements based upon a real (i.e., adjusted for inflation) rate of return equal to 3.5 percent, the real rate of return realized overall by steel firms during the last decade.*

[2] *During a period of increasing capacity requirements and increasing costs of capacity expansion, the revenue per ton required to earn the target rate of return on common equity employed for capacity expansion would exceed the revenue per ton required to earn the same rate of return for existing capacity. It should be noted that the price effect defined herein would, on average, provide the target rate of return on common equity.*

REVENUE REQUIREMENTS

During the 1975-1983 period, baseline revenue requirements are anticipated as follows:

REVENUE REQUIREMENTS FOR
BASELINE CONDITIONS
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Sales Taxes	$ 3.82	$ 13.44
Operations & Maintenance Expenses	78.17	282.87
Capital Related Costs		
Depreciation	$ 4.31	$ 13.70
Property Taxes	0.92	3.15
Net Interest Expenses	1.26	4.41
Income Taxes	2.57	7.06
Net Income Requirement	5.07	13.92
SUBTOTAL	$14.13	$ 42.30
Revenue Requirements	$96.11	$338.61

Required revenues, without consideration of additional pollution control equipment, will amount to $96.1 billion in the short run and $338.6 billion in the long run. These baseline revenue requirements will approximate $32.0 billion per year during the 1975-1977 period and are expected to increase to $37.6 billion per year in the long run. Of these revenue requirements, more than 80 percent represent operating costs. The remaining revenues are associated with capital-related charges with the exception of sales taxes which approximate 4 percent of revenues.

In computing required revenues, PTm(Steel) details costs by category and attributes these costs to their appropriate sources. Revenue requirements associated with environmental regulations are as follows:

REVENUE REQUIREMENTS FOR WATER AND AIR POLLUTION CONTROL EQUIPMENT

(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Water Pollution Control Equipment		
Phase I Processes	$0.11	$0.98
Phase II Processes	0.53	3.25
TOTAL	$0.64	$4.23
Storm Runoff	*	0.20
Other Water	0.07	1.32
GRAND TOTAL	$0.73	$5.75
Air Pollution Control Equipment		
Stack Emissions	$0.69	$2.78
Fugitive Emissions	0.10	2.44
Other Air	0.07	0.47
TOTAL	$0.86	$5.68

**Less than $5 million*

Exhibits 21 and 22 provide revenue requirements allocated to baseline conditions and water and air pollution control equipment by cost category for the 1975-1983 period and by source of requirement by time period, respectively.

Additional revenues for the water and air pollution control equipment required to meet effluent guidelines, emission standards and miscellaneous environmental regulations will approximate $1.6 billion in the short run and $11.4 billion in the long run. These increases in required revenues amount to 1.6 percent of the baseline in the short run and 3.4 percent in the long run.

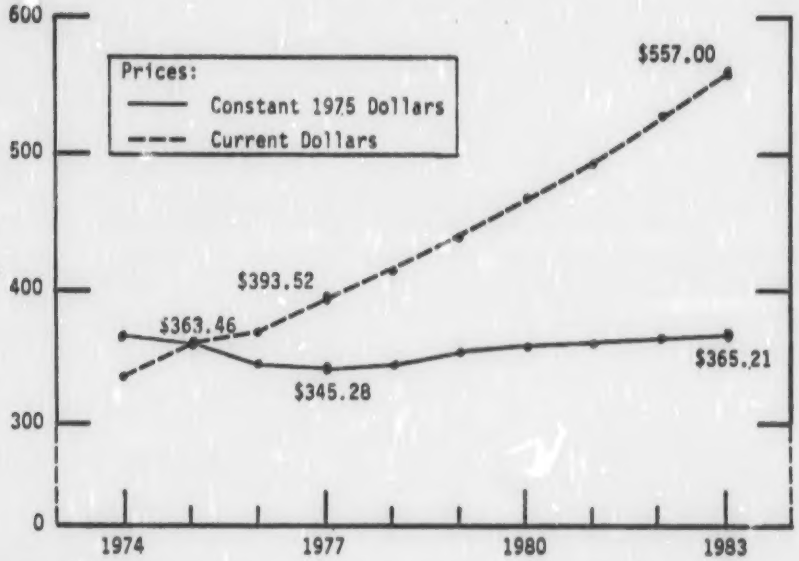
Thus more than $0.5 billion per year in additional costs will need to be recovered during the 1975-1977 period. These annual revenue requirements will continue to increase as more pollution control equipment is added. By 1983 the impact will be nearly $2.0 billion per year. During the 1975-1983 period, revenues required due to the addition of pollution control equipment will average $1.3 billion per year.

The major component of these added revenue requirements is capital-related charges. Depreciation and other capital-related costs account for more than 50 percent of the long-run increase in revenue requirements. Of the total $11.4 billion associated with pollution control equipment in the long run, $3.0 billion represents earnings before income taxes--an amount which would permit the steel industry to achieve its historic rate of return on common equity.

PRICE EFFECTS

Average steel prices can be determined by dividing revenue requirements by the appropriate level of steel shipments. For example, the baseline price per ton of domestic steel shipped during 1975 is estimated to have averaged $363.46. This average price is expected to decline in real terms (i.e., adjusted for inflation) through 1977 due to continued productivity gains and increasing capacity utilization factors. However, sectoral inflation in the labor and basic raw material markets is expected to result in a real increase in long-run prices. In real terms, the average baseline price level anticipated in 1977 is $345.28. By 1983 the baseline price is expected to increase to $365.21 in real terms.[3,4] Baseline price levels, in both nominal and real terms, are as follows:

BASELINE PRICE LEVELS



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[3] *These baseline prices include a charge of $4.11 per ton in 1977 and $3.25 per ton in 1983 which is associated with the continued operation of pollution control equipment placed into service prior to 1975.*

[4] *Once again, the baseline price would, on average, provide the target rate of return on common equity. In order to earn this rate of return on common equity for capacity expansion in excess of rounding out existing steel finishing capacity, the 1983 baseline price would need to be $387.18. At this price level, the rate of return for existing capacity would be significantly higher than the target.*

Pollution control equipment placed into service during the 1975-1983 period is expected to increase the average 1983 price per ton of steel from $365.21 to $381.96, an increase of $16.75 per ton as follows:

AVERAGE PRICE EFFECTS FOR WATER AND AIR POLLUTION CONTROL EQUIPMENT
(1975 dollars per ton)

	Short-Run 1977	Long-Run 1983
Water Pollution Control Equipment		
Phase I Processes	$ 0.56	$ 1.76
Phase II Processes	2.46	4.22
TOTAL	$ 3.02	$ 5.98
Storm Runoff	0.02	0.53
Other Water	0.38	3.09
GRAND TOTAL	$ 3.42	$ 9.60
Air Pollution Control Equipment		
Stack Emissions	$ 2.98	$ 2.70
Fugitive Emissions	0.54	3.70
Other Air	0.30	0.75
TOTAL	$ 3.82	$ 7.15

As previously mentioned, PTm(Steel) permits the computation of the price per ton on an overall basis (Exhibit 23), by steel product (Exhibit 24), by stage of production (Exhibit 25), and by value-added at each process (Exhibit 26). These exhibits segment the 1983 price into the components associated with baseline conditions and water and air pollution control equipment. In addition, overall price levels are provided for selected years (1974, 1977, 1980 and 1983) to permit a computation of price trends with and without the impact of environmental regulations.

By 1977 the added requirements of pollution control equipment will increase prices by 2.1 percent, with slightly more than one-half associated with air pollution control. In the long run the impact of environmental regulations on price levels will total 4.6 percent, with water pollution control equipment responsible for a 2.6 percent increase.

Some industry observers would conclude that these price increases would have a negative impact upon steel shipments. However, it should be noted that average steel prices, measured in 1975 dollars, will approximate $382 per ton by 1983, up approximately $16 from comparable price levels recorded in 1974. Thus while steel prices will increase due to environmental regulations, steel customers will face increases in nominal steel prices which will exceed the rate of overall inflation within the economy by only 0.5 percent. Under these conditions the impact of environmental regulations, while negative, would not result in significant declines in the level of domestic steel shipments.

When price effects are evaluated by steel product, the price increases range from $7.99 per ton for direct shipments of semi-finished products to $25.31 for nails and other wire products, from 3.5 percent for direct shipments of semi-finished products to 5.6 percent for cold finished bars. The price effects of water pollution control equipment vary widely from one steel product to another since the major costs of the effluent guidelines fall on the finishing mills. On the other hand, air emission standards are specified only for iron and steelmaking processes (including coke ovens), thus reducing the variation in price increases among steel products.

When price effects are computed for each process, the most significant effects are associated with coke ovens where the 1983 cost of coke is expected to increase by more than $8 per ton.[5] Emission standards will also adversely effect all furnaces, with open hearth and electric furnaces incurring added costs of more than $3.50 per ton. Effluent guidelines impact all processes, but the finishing processes represent more than 50 percent of the total impact for water pollution control equipment.

SENSITIVITY ANALYSIS: ALTERNATIVE BASIC RAW MATERIAL COSTS

A major factor in the determination of overall price levels is the assumption regarding basic raw material costs. The above-mentioned analysis of baseline conditions includes iron ore, metallurgical coal and scrap metal prices specified at market values which reflect sectoral inflation, declining productivity in underground coal mines, and comparable costs for hot metal and scrap metal charges into steelmaking furnaces.

In order to determine the impact of alternative basic raw material costs, TBS analyzed a set of conditions wherein iron ore, metallurgical coal and scrap metal prices escalate from observed 1972 prices by the price/cost indices forecast by Data Resources, Inc.[6] Utilizing these raw material costs, baseline prices would approximate $317 per ton and $313 per ton in 1983. These average prices would represent a significant decline from the above-mentioned baseline steel prices of $345 per ton in 1977 and $365 per ton in 1983.

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[5] *This estimate of the price effect for coke ovens ignores the OSHA requirements recently proposed. It should also be noted that ADL's estimate of cost impacts on coke ovens was significantly greater than those based upon NUS/Rice engineering cost estimates.*

[6] *"Steel Raw Materials Long-Term Forecast", DRI Steel Forecast Service, summer 1975.*

SENSITIVITY ANALYSIS: LESS THAN FULL COST PASS-THRU

Analyses of revenue requirements and related price effects have focused thus far upon the impacts when the steel industry is able to recover all costs associated with pollution control abatement, including a target rate of return on common equity equal to that earned on productive assets. Some industry observers would seriously question this assumption arguing that import competition or government regulation would constrain the ability to pass through these costs. Clearly, if price increases due to expenditures for pollution control were large (i.e., greater than those projected) or competition from imports and/or substitutes was substantial, either a measurable decline in demand or a reduction in rate of return would occur.

In an effort to evaluate the economic implications of less than full cost pass-through, TBS computed the revenue requirements, price effects and external financing needs under operating conditions where the costs of pollution control equipment are not passed through to steel companies and steel firms absorb these unrecovered costs through a realization of net income below historic levels. These costs of pollution control equipment were segmented further into operating expenses and capital-related charges.

As previously discussed, revenue requirements for water and air pollution will total $11.4 billion in the long run. If these costs were not passed through, approximately 65 percent would be absorbed by reductions in net income. These costs would deplete more than one-half of the previously-cited baseline net income of $13.9 billion. Given that operating costs and capital charges for pollution control equipment are approximately equal, zero cost pass-through would imply a 25 to 30 percent reduction in net income, for either operating costs or capital-related charges. These combined decreases in net income would result in a 2 percent decline in revenue requirements.

SENSITIVITY ANALYSIS: ALTERNATIVE RATES OF RETURN ON EQUITY

Throughout this study, TBS has considered net income, or the return on common equity, as a cost of doing business. This approach recognizes that a relatively capital intensive industry like the steel industry must be able to earn a competitive rate of return on its investment so that it can attract new capital to finance its growth.

During the last decade the steel industry did not expand its capacity and raised less than $1.0 billion in external financing. Under these conditions its low rate of return relative to other manufacturing industries was not a liability. However, the steel industry must expand during the next decade if domestic steel shipments are to keep pace with the historic trend. Within this environment external capital must be attracted.

In an effort to determine the revenue requirements and price effect of alternative rates of return on equity, TBS analyzed rates of return equal to those historically observed for all manufacturing firms, for steel firms overall, and for steel operations by major steel companies.

Manufacturing firms have achieved average rates of return of 7 percent in real terms (adjusted for inflation) during the last decade. During the same period steel firms have been able to earn only 50 percent of this rate. Unfortunately, steel firms have been able to maintain even this lackluster profitability only by diversifying into non-steel ventures and integrating backward into mining and/or forward into fabrication, bridge building, ship building, etc.

While the profitability of steel operations is not detailed in annual financial statements, major integrated steel firms, representing more than 50 percent of raw steel production, have provided data to TBS through the AISI on the profitability of steel operations. From 1972 through the first nine months of 1975, steel operations within these major steel producers have realized real rates of return of minus 1 percent. That is, these operations would have operated at a loss if raw materials were purchased at market value rather than transferred from another division within the firm.

Any reduction in steel prices below the baseline levels previously cited would reduce profitability, would increase the industry's financing needs, and would decrease the likelihood that these funds could be attracted to the steel industry at acceptable terms. A more thorough discussion of the economic impact associated with operating steel facilities at a loss follows in the next section of this report.

If steel firms were able to increase their profitability from existing levels overall to the average of all manufacturing firms, baseline prices would need to increase by about 3 percent in both the short and long run. These price increases would flow through to net income and would increase retained earnings by more than 30 percent in the long run. This increase in the target rate of return on common equity would increase the price effect associated with pollution control equipment from 4.6 percent to 4.9 percent. As will be discussed in the next section, increased profitability will not only reduce the financing requirements of the industry in absolute terms, but also increase the attractiveness of its financing instruments in the capital markets.

SENSITIVITY ANALYSIS: PRICE AND INCOME ELASTICITY

Most economists attempt to evaluate economic impact within the context of the classical supply and demand model and its assumptions regarding price and income elasticities and cross-elasticities. Unfortunately, these kinds of elasticity estimates are not readily available for the steel industry, especially at the level of steel products. Those estimates which do exist imply that demand is inelastic in the range of small price movements and, in fact, that the elasticity with respect to price is less than the elasticity with respect to income.[7] Under these conditions, a firm would increase its price when costs increase and/or when demand at a given price decreases.

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[7] *See, for example, "Economic Factors Affecting Pricing Decisions," J. Fred Weston and Edward Rice, November 1975.*

While this study did not consider directly the impact of domestic prices relative to import competition, knowledgeable industry observers believe that domestic steel firms are now competitive with imported steel due to dollar devaluation, relative rates of inflation in the labor and raw material markets, and other favorable trends. In addition, it is quite likely that foreign steel producers will face comparable environmental requirements in the near future.

7. ECONOMIC IMPACT OF ENVIRONMENTAL REGULATIONS: EXTERNAL FINANCING NEEDS

Once revenue requirements have been determined, external financing requirements can be computed as the difference between total applications and internal sources of funds. Capital expenditures for capacity expansion and modernization, including increases in construction work in progress, dominate baseline applications; however PTm(Steel) also includes changes in working capital and refundings of long-term debt. Internal cash flows include depreciation charges and retained earnings. Finally, external financing needs are met through issues of long-term debt and common stock. The mix of debt and equity issues is based upon the maintenance of an historic capital structure. Exhibit 20 summarizes these flows within the financing module by means of a schematic diagram.

Perhaps the best summary of baseline external financing requirements can be obtained from the following sources and applications of funds:

BASELINE SOURCES AND APPLICATIONS OF FUNDS
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Capital Expenditures	$ 8.72	$ 27.50
Increase in Working Capital	1.15	4.21
Refunding of Long-Term Debt	0.47	1.22
TOTAL APPLICATIONS	$10.34	$ 32.93
Depreciation	$ 4.31	$ 13.76
Retained Earnings	2.25	6.18
Internal Sources	$ 6.56	$ 19.94
Issues of Long-Term Debt	$ 2.29	$ 6.19
Issues of Common Stock	1.49	6.79
External Financing	$ 3.77	$ 12.99
TOTAL SOURCES	$10.34	$ 32.93

Exhibits 27 and 28 provide sources and applications of funds for the industry baseline and for pollution control equipment in the short and long run, respectively.

In the short run, total baseline applications of funds are expected to be $10.3 billion, of which nearly $6.6 billion will be generated internally through depreciation and retained earnings. The remainder, nearly $3.8 billion, must be obtained from the capital markets in the form of new issues of long-term debt and common stock. These external financing requirements in the short run will be nearly $1.3 billion per year. In the long run the external financing needs are projected to be $13.0 billion, an average of $1.4 billion per year.

During the last decade the steel industry has depended upon external sources for less than $1.0 billion.[1] These external financing requirements represented only 5 percent of total applications. The $13.0 billion of external financing required in the long run represents nearly 40 percent of total baseline applications. Thus the steel industry must attract significant amounts of capital to finance expansion and modernization of steel operations after more than a decade of negligible financing activity. Environmental regulations will increase these financing requirements.

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[1] *In fact, internal sources exceeded total applications by nearly $0.6 billion during 1973 and 1974.*

Financing pollution control equipment during the 1975-1983 period will require more than $4.5 billion in external financing. These requirements are as follows:

EXTERNAL FINANCING REQUIREMENTS FOR
WATER AND AIR POLLUTION CONTROL EQUIPMENT
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
Water Pollution Control Equipment		
Phase I Processes	$ 0.24	$ 0.48
Phase II Processes	1.18	1.39
TOTAL	$ 1.42	$ 1.87
Storm Runoff	0.02	0.12
Other Water	0.15	0.49
GRAND TOTAL	$ 1.59	$ 2.49
Air Pollution Control Equipment		
Stack Emissions	$ 1.16	$ 0.93
Fugitive Emissions	0.62	0.95
Other Air	0.12	0.18
TOTAL	$ 1.90	$ 2.06

Exhibit 29 details these external financing needs by time period.

External financing requirements represent more than 60 percent of the total applications of funds associated with pollution control equipment. In addition, they increase total financing needs by 35 percent in the long run.

The most serious financing problem, however, exists in the short run when environmental regulations will require $3.5 billion, a near doubling of the financing requirements for expansion and modernization. Nearly 90 percent of the funds associated with pollution control must be financed in the short run through external sources. These 1975-1977 capital market requirements pose serious problems for the steel industry.

First, these external financing requirements far exceed historical flows. The 1972-1974 period was the most prosperous period in the history of the steel industry. During these years, the industry was able to generate $7.1 billion from internal sources for all of its activities--steel operations, mining, fabrication, non-steel operations, etc.--and had applications of less than $6.7 billion. By way of comparison, the above-mentioned total requirements for steel operations alone during the 1975-1977 period total $14.3 billion in applications and $7.3 billion in external financing. Thus total uses of funds are expected to more than double, with internal sources increasing marginally from $6.7 to $7.0 billion. The net result is a significant gap to be filled by issues of long-term debt and common stock.

Second, the industry's level of profitability has seriously lagged the average of all manufacturing with the exception of 1974 when the relaxation of price controls and worldwide shortages of both steel and basic raw materials enabled the steel industry to raise its prices and fully utilize its productive capacity. Overall steel industry rates of return in 1974 equalled the all-manufacturing average, with natural resources extraction and some non-steel activities (e.g., chemicals) far exceeding the returns on steel operations. Over the last decade, however, the steel industry's rate of return on common equity has averaged one-half of that for all manufacturing firms when profitability is adjusted to reflect inflationary trends.

Third, the steel industry in the past has been burdened with a poor assessment by financial analysts and investors in general. During the last decade, the industry has not expanded its capacity and, therefore, has not required infusions of capital. This static operating environment, when coupled with a dismal record of profits, helps to explain the industry's performance in the stock market. From 1970 through 1974 the ratio of market value to book value for the six major integrated steel firms approximated 0.5.[2] That is, investors have valued the industry's securities at one-half the amount which these securities would yield if the industry could liquidate its assets at book values. If the steel industry were required to issue common stock to finance its expansion and/or pollution control equipment under these capital market conditions, the value of the holdings by existing stockholders would be diluted, thus discouraging further investment. Unless stock prices increased to a level approximating book value, the need for continued financing in the long run would discourage investors in the short run.

Finally, if the steel firms were unable to issue common stock at prices near book value, they would have the option of cutting back on expansion plans or modifying the historic debt-to-equity ratio of 30 to 40 percent. If the industry were to finance its expansion and pollution control equipment needs entirely with long-term debt issues, the debt-to-equity ratio would increase to 100 percent by 1983. Even if this mix of debt and equity were acceptable to investors, the cause for the shift and its magnitude would most likely have an adverse impact upon the current bond ratings of firms within the steel industry. Under these conditions, most steel firms would cut back on their capacity expansion plans.

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[2] *The stock market recovery during the 1st Quarter of 1976 has significantly improved the ratio of market values to book values for steel firms. The first new common stock issue by a major integrated steel firm since the 1950s was offered on March 29, 1976 by Inland Steel.*

The above-mentioned analysis does not necessarily imply that the steel industry cannot finance its expansion and its pollution control requirements in the short run. While there is little doubt that financing these requirements will be extremely difficult, TBS believes that the task is manageable. However, the industry must be able to pass through the increased operating costs and capital-related charges associated with expansion, modernization and environmental regulations. In addition, the industry must be able to earn a competitive return on its common equity.

It is TBS's opinion that the steel industry will be unable to finance its expansion, modernization and pollution control requirements without earning a rate of return on common equity at least equal to those realized by other manufacturing firms.[3]

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[3] *Some industry observers would argue that financing difficulties could be eased further if steel firms could earn a rate of return which includes a premium to counter the uncertainty associated with the cyclical nature of the domestic steel industry and the industry's inability to earn an adequate return in the past.*

Several obstacles stand in the way of the steel industry's meeting these conditions. The increased prices implied by the pass-through of all pollution control costs, including an adequate return on common equity, could adversely impact the ability of domestic producers to compete with imports and substitute materials. However, TBS projects that future prices will increase by less than 0.5 percent in real terms from 1974 levels. In addition, most knowledgeable observers of the steel industry believe that the domestic steel industry is now cost competitive with foreign steel producers. Future capacity expansion and the shift to more efficient steelmaking should increase this comparative advantage.

Over the last decade the steel industry has been unable to earn an adequate return. During this period foreign competition was able to increase its share of the domestic steel market. This competitive pressure, coupled with price controls on steel products, limited profitability. The termination of formal price controls and worldwide steel shortages, both of which took place in 1974, enabled the domestic steel industry to raise its prices and to earn a competitive rate of return. Given the current competitive position of domestic steel producers, an elimination of government restraints on price increases should permit the steel industry to achieve adequate rates of return without adversely impacting its ability to compete with foreign producers. In addition, the format of the current labor-management contract minimizes the threat of future steel strikes. During the late 1950s and 1960s, frequent strike threats permitted imported steel to increase its penetration of the domestic market.

Some observers of capital market conditions have forecast a shortage of capital in the near future. While unwilling to state without qualification that capital market conditions will not restrict future economic growth, TBS has projected capital availability by means of three, equally plausible scenarios. Within two of these scenarios, the overall availability of capital in the near future is not a problem.

The ability of major non-financial corporations to finance their operations appears to be feasible under all three scenarios--the unanswered question is the difficulty of so doing in terms of the cost of capital in the form of interest rate or stock price. The capital availability question is most relevant to the marginal, interest-sensitive borrower. Normally, these borrowers would include state and local governments, small business firms, and individuals requiring home mortgages and/or consumer credit.

SENSITIVITY ANALYSIS: STEEL SHIPMENTS FORECAST

Perhaps the most uncertain element in the set of industry conditions thus far analyzed would be the forecast of the future level of steel shipments. In establishing its baseline forecast, TBS assumed that domestic steel shipments would rebound from the recession levels in 1975 to the long-run trend by 1977. Recognizing the sensitivity of capital expenditures and related external financing needs to this forecast of domestic steel shipments, TBS evaluated alternative forecasts of domestic steel shipments, including the following:

- shipments would recover from the current recession by 1977 and would exceed the long-run trend by 10 percent in subsequent years,

- shipments would not fully recover from the current recession and would remain permanently below the long-run trend by 10 percent, and

- shipments would recover more slowly from the current recession and would not reach the long-run trend until 1980.

OPTIMISTIC FORECAST OF SHIPMENTS

The short-run financing problem uncovered in the previous analyses would be exacerbated if the industry growth were to exceed the long-run trend after 1977. Under these conditions capital expenditures for capacity expansion would be $13.5 billion in the short run, $8.4 of which would require external financing. Thus baseline capital expenditures would increase from $8.7 to $13.5 billion, or 55 percent, all in the form of an increase in construction work in progress. External financing requirements for capacity expansion and modernization would increase from $3.8 to $8.4 billion, an increase of more than 120 percent.

While the short-run incremental impact of pollution control equipment under this optimistic forecast of shipments would increase by less than 10 percent for capital expenditures and external financing, the combined requirements for capacity expansion, modernization and pollution control equipment under these conditions would be excessive. Total short-run capital expenditures and external financing requirements would be $17.7 billion and $12.2 billion, respectively. On an annual basis, these capital expenditures would average $5.9 billion per year, $4.1 billion of which would be financed within the capital markets. These external financing requirements in the short run represent a 67 percent increase over the previously cited $2.4 billion.

In the long run, the requirements of optimistic growth would be no less acute. Total capital expenditures would increase from $34.3 to $43.4 billion with external financing requirements increasing from $17.5 to $24.7 billion.

It is TBS's opinion that these optimistic growth requirements, coupled with the capital needs for pollution control equipment, would exceed the industry's financing abilities--especially in the short run.

PESSIMISTIC FORECAST OF SHIPMENTS

If the sharp decline in steel shipments during 1975 represents a permanent, structural shift away from steel products or toward lighter materials, whether it be thinner gauge steel or substitute materials, the short-run financing problem within the industry would be eased. Under these conditions total short-run capital expenditures would decline from $12.6 to $9.6 billion, a decline of nearly 25 percent. Related external financing requirements would decline from $7.3 to $4.6 billion, a decline in excess of 37 percent. Thus annual external financing needs which averaged more than $2.4 billion under baseline conditions would decline by $0.9 billion.

It is TBS's opinion that a combination of slower expansion of capacity, continued modernization of existing capacity, and compliance with environmental regulations would be quite manageable, in both the short and long run.

SLOW RECOVERY FROM RECESSION

If the sharp decline in steel shipments during 1975 represents a temporary, but prolonged setback for the steel industry, the previously mentioned short-run financing problem is somewhat eased. Under these conditions, total short-run capital expenditures decline from $12.6 to $11.5 billion with a near dollar-for-dollar decrease in external financing requirements. Since the slow recovery does not alter the long-run trend, no change in the long-run impacts are evident with the exception of minor differences attributed to the timing of expenditures.

SENSITIVITY ANALYSIS: PLANNING UNDER UNCERTAINTY

All of the above-mentioned sensitivity analyses assume that the steel industry is able to forecast future economic conditions with great accuracy and plan accordingly. A far more likely set of conditions would be those wherein the industry would plan for a rebound from the 1975 recession to the long-run trend in 1977, but the uncertainty in steel shipments would result in operations above or below those levels anticipated.

For example, the industry might expand to meet the long-run trend only to find that the 1975 recession represented a structural shift in steel consumption. Under these conditions, unit costs would increase due to lower capacity utilization and higher fixed costs per ton of shipments. It is likely that steel firms would attempt to recover these higher costs through price increases without which net income would decline below the target rate of return on common equity. If shipments fell below the long-run trend by 10 percent, price adjustments would result in increases of approximately $6 per ton in the long run.

If shipments were to exceed the long-run trend by 10 percent and capacity additions were planned to meet trend requirements, the steel industry would find itself in a position where it could decrease its price and continue to achieve the target rate of return. Facing capacity shortages, it is likely that firms within the steel industry would maintain price, increase internal sources by realizing a rate of return on common equity in excess of their target, and thereby reduce external financing needs.

This analysis, coupled with the earlier conclusion that the steel industry would have extreme difficulty in financing its expansion plans under the optimistic shipments forecast, would suggest that the steel industry would not undertake rapid expansion at this time.

SENSITIVITY ANALYSIS: ALTERNATIVE RATES OF RETURN ON EQUITY

In the previous section the economic impact of alternative rates of return on equity was analyzed in terms of revenue requirements and price effects. Equally important is the impact of profitability upon external financing needs. An increase in the rate of return on common equity, other things equal, would increase net income, retained earnings and internal cash generation, and decrease external financing requirements. Furthermore, maintenance of a given capital structure would imply that this increase in retained earnings would result in a complementary decrease in common stock issued.[4]

If steel firms were able to achieve a rate of return on equity comparable with the average of all manufacturing firms, short-run retained earnings would increase from $5.4 to $6.8 billion with a net decrease in external financing needs from $9.6 to $8.4 billion. Thus while increased profitability would considerably enhance the ease with which the steel industry could obtain its external financing, it would not significantly reduce its financing needs.

Far more drastic would be the financing difficulties which would coincide with a continuation of the inadequate profit levels on steel operations reported by the major integrated steel firms.[5] Under these conditions retained earnings in the short run would decline by nearly 50 percent from $5.4 to $2.9 billion. The corresponding increase in external financing needs would be from $9.6 to $11.8 billion. This 23 percent increase in external financing requirements certainly would exacerbate the short-run financing problem; however, the inability to earn an adequate return on common equity by itself would undermine the ability of steel firms to attract capital at acceptable rates.

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[4] *It should be noted that the increase in net income results in increased revenues and, therefore, increased working capital requirements. This increase in working capital would be financed through a mix of debt and equity.*

[5] *Once again, it should be noted that the rate of return on steel operations alone is not publicly available from annual financial statements. Estimates of this rate of return have been provided by AISI.*

SENSITIVITY ANALYSIS: HIGHER COST OF CAPITAL

Many industry observers fear that the external financing burden of the next decade will erode security ratings on its long-term debt issues and/or require increased yields to investors on its common stock. In order to evaluate the impact of an increased cost of capital upon external financing requirements and average steel prices, TBS increased the long-term interest rate and the target rate of return on common equity by 1 percent.

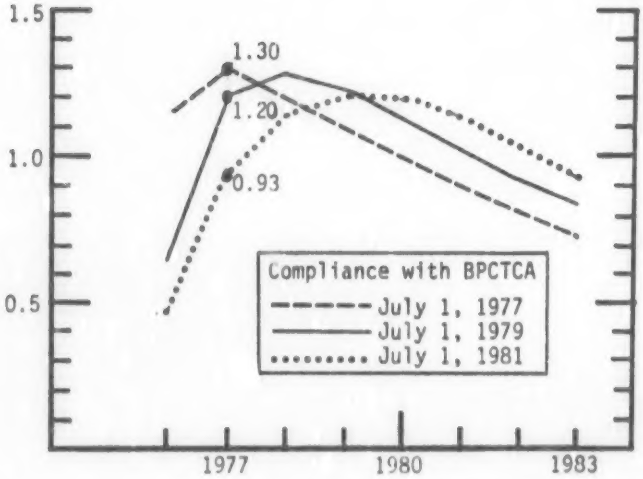
Under these conditions, total long-run external financing requirements decline from $17.5 to $16.8 billion--a decrease of 4 percent. This results from the increase in net income and retained earnings, an increase which results in a price increase of less than $3.50. Thus a 1 percent increase in the cost of capital would result in an average price increase of less than 1 percent.

SENSITIVITY ANALYSIS: BPCTCA COMPLIANCE SCHEDULE

As described in an earlier section, the date by which full compliance with BPCTCA is obtained has a significant effect on the timing of capital expenditures. Alternative compliance dates affect not only the timing of external financing requirements, but also the amount required in any given time period.

Both of these impacts can be observed in the following figure:

CUMULATIVE EXTERNAL FINANCING OF
ALTERNATIVE BPCTCA COMPLIANCE DATES
(billions of 1975 dollars)



Compliance by the 1977 statutory date for BPCTCA requires $1.3 billion in short-run external financing. In addition, these financing requirements peak in 1977 and steadily decline thereafter as a result of the increased cash flow from related internal sources, primarily in the form of depreciation.

The short-run external financing needs associated with a 1979 compliance schedule is $1.2 billion, reducing the total financing requirements of environmental regulations by 3 percent in the short run. While this delay in the BPCTCA compliance schedule appears to increase financing needs during the 1975-1983 period, these streams of cumulative financing needs converge as the related water pollution control equipment becomes fully depreciated. Delay of the compliance schedule until 1981 decreases short-run financing requirements a total of $0.4 billion, or 10 percent.

8. OTHER IMPACTS OF ENVIRONMENTAL REGULATIONS

Environmental regulation in the steel industry will have other economic effects. The most significant of these other impacts will concern changes in the industry's consumption of energy and its levels of employment. Effects may also be expected in communities where significant amounts of steelmaking are concentrated and in the nation's balance of trade. This section discusses these impacts.

ENERGY IMPACTS

The manufacture and finishing of iron, steel and steel mill products requires extremely large amounts of energy. In recent years the steel industry has used approximately 20 percent of the total energy consumed within the manufacturing sector. At least half of this amount is consumed in the ironmaking stage of production, which includes both coke ovens and blast furnaces.

In calculating the energy requirements for the steel industry, TBS relied on estimates of fuel and electrical power consumption per ton of throughput for each process. These engineering estimates were provided by Arthur D. Little for the production processes and by EPA technical contractors and alternatively by ADL for water and air pollution control equipment. With the exception of metallurgical coal, these estimates do not include the energy content of the raw materials used in the steelmaking process. Thus the energy consumed in mining and/or preparation of iron ore, limestone, steel scrap, oxygen, and fluxes and alloying materials is not included. In addition, non-process related consumption of energy is not included.

Because of its large magnitude, the energy content of metallurgical coal used as input to the coke ovens was included in these calculations. Furthermore, the ADL energy estimates include the energy generated in the forms of blast furnace and coke oven gas, which is typically used in downstream processes. The production of these gases results in a net energy credit being assigned to these two processes.

A summary of energy requirements is as follows:

ENERGY REQUIREMENTS
(quadrillion Btu)

	Short Run 1975-1977	Long Run 1975-1983
Baseline	6.71	22.95
Pollution Control Equipment		
Water	0.03	0.33
Air	0.01	0.11
TOTAL	0.04	0.44
GRAND TOTAL	6.75	23.39
Pollution Control as a Percent of Basline	0.06%	1.9%

Exhibits 30 and 31 detail these energy requirements by time period and by stage of production and by environmental regulation, respectively.

The energy impact of environmental regulations is minor when compared to the large energy requirements for steel production. Pollution control equipment placed into service during the 1975-1983 period will increase energy consumption by 0.4 quadrillion Btu, approximately 2 percent of the baseline levels.

When the energy consumption of pollution control facilities already in place is included, total energy use associated with environmental regulations is calculated to be 0.8 quadrillion Btu, or less than 4 percent of the industry total. Water pollution equipment is responsible for more than 60 percent of total pollution control energy consumption with air pollution equipment responsible for the remainder.

The energy requirements to operate all pollution control facilities within the steel industry will be approximately 135 million barrels of residual fuel oil or equivalent during the 1975 to 1983 period. These requirements amount to 41,000 barrels per day.

Projections of requirements utilizing NUS/Cyrus Rice and Arthur D. Little estimates of energy use associated with water pollution control equipment are comparable--0.5 quadrillion Btu, including equipment placed into service prior to 1975. However, the ADL estimate of energy requirement for air pollution abatement is twice that based upon the energy use assumed by Battelle Columbus Laboratories and EPA-Durham. This significant difference follows from the air flow assumptions employed by EPA-Durham in its assessment of fugitive emission requirements.

EMPLOYMENT EFFECTS

The construction, installation, and operation of pollution control facilities will create additional jobs. Total employment from the operation of these facilities is summarized below:

SUMMARY OF STEEL INDUSTRY EMPLOYMENT [a]
(thousands of jobs)

	Short Run 1977	Long Run 1983
Baseline Conditions	444.7	444.5
Water Pollution Control	1.4	9.0
Air Pollution Control	.4	3.5
TOTAL EMPLOYMENT	446.5	457.0

[a] *Includes process-related direct and indirect employees only.*

Exhibits 32 and 33 detail these employment effects by time period and by stage of production and by environmental regulation, respectively. The decline in baseline employment is the result of increasing domestic shipments being more than offset by the underlying assumption that productivity will continue to improve at its historical rate of 2.3 percent per year.[1]

It is anticipated that 1,800 steel industry jobs will be required by 1977 to operate the additional pollution control equipment placed into service in or after 1975. These new jobs represent less than 1 percent of the industry's total employment and are in addition to the 2,400 jobs linked to the operation of pollution control equipment placed into

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[1] *This improvement in productivity alone would be responsible for the loss of more than 31,000 jobs in the short run and more than 88,000 jobs by 1983 if production requirements did not increase.*

service prior to 1975. By 1983, compliance with all environmental regulations will have created 12,500 additional jobs--a 3 percent increase over baseline employment. In total, more than 14,900 jobs will be required by 1983 to operate pollution control equipment within the steel industry.

In addition to jobs created directly within the steel industry, employment will also be created in the manufacture and installation of pollution control equipment. Utilizing the national average of 20 jobs per million dollars of annual production of pollution control equipment, the previously cited long-run capital expenditures of $6.8 billion will generate an annual average of 15,000 jobs in pollution control equipment-related industries. This employment will, in turn, create additional employment in unrelated industries.

Some reduction in production labor may offset these employment increases. Jobs could be lost if the higher prices due to the cost of pollution control result in a decline in domestic steel shipments. Jobs could also be lost if specific mills or plants were shut down. However, shutting down one operation might require expanding production at another plant. The net effect of either of these conditions would be a decline in employment only to the extent that production is shifted from more labor-intensive operations to less labor-intensive ones or domestic production is replaced by imports and/or substitute materials.

COMMUNITY EFFECTS

The effect on communities of compliance with the proposed environmental regulations will vary by geographic region. Where plants are large and where significant amounts of steelmaking capacity are concentrated (e.g., in Pennsylvania with over 20 percent of steelmaking capacity), closing of processes at one plant may result in additional jobs at another plant nearby.

Steel facilities in all but EPA Regions III and V are scattered, frequently small and specialized. Production lost from closures in other regions may not be made up nearby. It will be replaced, possibly by very distant and unrelated plants. Therefore, closures in these areas will more likely result in loss of jobs to a community than would be true in EPA Regions III and V. However, should implementation of the effluent guidelines result in closures, some communities where the resulting lost production is supplemented will experience growth.

A direct assessment of potential community effects requires a detailed analysis of facilities which are marginally profitable and are likely to curtail operations when confronted with the necessity of installing pollution controls. Such specialized micro-economic analysis requires plant-specific data which are not generally available. Consequently, the EPA has been unable to conduct detailed economic studies of all such marginal facilities.

EPA has conducted an in-depth analysis of the potential economic effects of pollution control costs on the eight steel plants in the Mahoning Valley region of eastern Ohio.[2] The study was prompted by the knowledge that (1) the regional economy depends heavily upon steel production, and (2) these steel operations are among the most marginal in the country as a result of a variety of economic factors.

The EPA study found that the imposition of pollution controls (or any other major increase in production costs) is likely to degrade substantially the profitability of these plants. In these situations, there is considerable risk that the steel firms might elect to curtail operations rather than make the investments in pollution control necessary to meet environmental regulations.

On the basis of the findings from the Mahoning Valley study, EPA decided to provide substantial relief from the industry-wide effluent guidelines. This relief for the plants in the Mahoning Valley delays and possibly reduces the major investment required for effluent controls.

BALANCE OF TRADE EFFECTS

Since the mid-1950s, there has been a steady and rapid growth in imports of steel into the United States. Domestic steel companies have met this competition through improved service, specialized production and transportation benefits, as well as some price cutting--all of which have decreased profitability. In 1974 steel imports resulted in an unfavorable balance of trade of $3.0 billion, the greatest deficit of the decade.

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[2] *Economic Impact of Pollution Control Regulations on Steel Plants in the Mahoning River Valley*, *Booz, Allen, and Hamilton, Inc., March 1976.*

Compliance with the pollution control regulations will result in price increases on the order of $7 per ton in 1977 and $17 per ton in 1983. Thus competitive pressure may increase. However, as mentioned previously, the steel customer will face increases in nominal steel prices only slightly in excess of the rate of inflation in the overall economy.

A second mitigating factor is that worldwide demand approached worldwide capacity prior to the recent worldwide recession. At the same time foreign producers are experiencing an escalation in operating costs due to increased labor rates and raw materials prices. Foreign steel companies may voluntarily reduce exports to the United States in order to serve closer markets which would increase profitability through reduced transportation costs.

It is expected that foreign producers will face pollution abatement requirements in the near future. Thus the relative impact of public policy toward environmental issues within the United States and in foreign countries may play a dominant role in determining our balance of trade.

The final impact of these events on our balance of trade is unclear. Net imports of steel is the most difficult measure of demand to forecast since it is directly affected not only by domestic economic developments but by foreign ones as well. In addition, foreign steel has been an instrument of government policy in the past.

Under baseline conditions, net imports are expected to reach 16.7 million tons in 1980 and 18.9 million tons in 1985. In the short and long run, net imports will fall within 12 percent of these tonnages should total demand fluctuate 10 percent above or below the baseline.

9. THE COST AND ECONOMIC IMPACT OF PHASE II EFFLUENT GUIDELINES

The analysis which follows describes the impact of the Phase II Effluent Guidelines as published in the March 22, 1976 Federal Register. These Phase II guidelines include regulations for the control of water pollution from the primary breaking mills through the finishing mills, with the exception of the cold coatings (i.e., tin and chrome plating). The guidelines also make provision for the control of storm runoff, which is included under the requirements for Best Available Technology Economically Achievable (BATEA). Water pollution control costs for Phase I processes, cold coating costs, miscellaneous water regulations anticipated but not yet promulgated, and all costs of controlling air pollution are not included in this section.

The statutory date for achievement of Best Practicable Control Technology Currently Available (BPCTCA) is July 1, 1977. In many cases within the iron and steel industry this compliance date may not be achieved due to construction lead times which depend upon the specific situation at individual plants. The following analysis of the economic impact of the Water Act has been based upon an assumption that full compliance with BPCTCA requirements will occur sometime during the period between July 1, 1979 and July 1, 1981. The following analysis highlights the impacts of compliance by July 1, 1979.

CAPITAL EXPENDITURES

The capital expenditures required to meet the Phase II Effluent Guidelines are as follows:

CAPITAL EXPENDITURES FOR PHASE II EFFLUENT GUIDELINES
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
To meet BPCTCA	$1.20	$1.39
To meet BATEA	0.11	0.83
To meet NSPS	0.01	0.09
TOTAL	$1.32	$2.31

Because of the need to bring present steel production facilities up to BPCTCA standards, the relative impact of the Phase II Effluent Guidelines on capital expenditures will be greatest in the short run. These Phase II requirements are expected to exceed $1.3 billion during the short-run period--an amount representing more than 15 percent of baseline capital expenditures and nearly 76 percent of total expenditures for water pollution control equipment. More than 90 percent of Phase II capital expenditures during this period are associated with the BPCTCA guideline.

In the long run, capital expenditures required to meet the Phase II Effluent Guidelines are expected to increase to $2.3 billion. Thus these expenditures will decline to 8 percent of baseline requirements and less than two-thirds of water pollution control requirements. Since the cold coating process will be covered by a forthcoming guideline, $20 million in capital expenditures incurred by steel finishers have not been attributed to the Phase II Effluent Guidelines, in both the short and long run.

OPERATIONS AND MAINTENANCE EXPENSES

The operations and maintenance (O&M) expenses required to meet the Phase II Effluent Guidelines are as follows:

OPERATIONS & MAINTENANCE EXPENSES FOR PHASE II EFFLUENT GUIDELINES
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
To meet BPCTCA	$0.12	$0.96
To meet BATEA	*	0.24
To meet NSPS	-	0.01
TOTAL	$0.12	$1.21

*less than $5 million

All of the O&M expenses are associated with the BPCTCA guideline in the short run. These operating expenses will approximate $0.1 billion during this period, less than 0.2 percent of baseline O&M expenses.

In the long run, O&M expenses associated with the Phase II Effluent Guidelines are expected to amount to $1.2 billion, less than 0.5 percent of the baseline expenses and nearly one-half of the operating expenses associated with water pollution control.

REQUIRED REVENUES

The incremental revenues required to comply with the Phase II Effluent Guidelines are as follows:

REVENUE REQUIREMENTS FOR PHASE II EFFLUENT GUIDELINES
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
To meet BPCTCA	$0.51	$2.59
To meet BATEA	0.02	0.77
To meet NSPS	*	0.05
TOTAL	$0.53	$3.41

**less than $5 million*

Revenues exceeding $0.5 billion will be required during the short-run period to meet the increased operating and capital-related charges incurred for compliance with the Phase II guidelines.

These revenue requirements in the long run exceed $3.4 billion, increase the baseline requirements by 1 percent, and amount to nearly 60 percent of the requirements associated with water pollution control equipment. Cold coating processes, which are excluded from the Phase II guidelines, would require $20 million of additional revenues in the short run and $40 million in the long run.

PRICE EFFECTS

If the full annualized costs of the Phase II Effluent Guidelines are to be recovered, the implied price effects are as follows:

AVERAGE PRICE EFFECTS FOR PHASE II EFFLUENT GUIDELINES
(1975 dollars per ton)

	Short Run 1977	Long Run 1983
To meet BPCTCA	$2.31	$2.66
To meet BATEA	0.13	1.90
To meet NSPS	-	0.13
TOTAL	$2.44	$4.69

Thus the capital expenditures and O&M expenses required to comply with Phase II guidelines will increase the 1977 average steel price by $2.44 per ton, an increase of less than 1 percent over the baseline.

By 1983 the average price increase will amount to $4.69 per ton, or 1.3 percent of the baseline price.

EXTERNAL FINANCING

The external financing requirements associated with the above-mentioned capital expenditures are as follows:

EXTERNAL FINANCING REQUIREMENTS
FOR PHASE II EFFLUENT GUIDELINES
(billions of 1975 dollars)

	Short Run 1975-1977	Long Run 1975-1983
To meet BPCTCA	$0.72	$1.11
To meet BATEA	0.45	0.31
To meet NSPS	0.01	0.07
TOTAL	$1.18	$1.49

In the short run, $1.2 billion of external financing will be required. These financing needs amount to 32 percent of the baseline requirements during the 1975-1977 period. In addition, they comprise approximately 75 percent of the external financing for water pollution control equipment.

The long-run financing requirements will require $1.5 billion more, for an 11 percent increase in baseline needs.

ENERGY IMPACT

The energy requirements for the operation of pollution abatement mandated by the Phase II Effluent Guidelines are as follows:

ENERGY REQUIREMENTS FOR PHASE II EFFLUENT GUIDELINES
(quadrillion Btu)

	Short Run 1975-1977	Long Run 1975-1983
To meet BPCTCA	0.03	0.23
To meet BATEA	-	0.04
To meet NSPS	-	-
TOTAL	0.03	0.27

The energy requirements associated with the Phase II guidelines amount to 0.03 quadrillion Btu in the short run and 0.27 quadrillion Btu in the long run. This long-run energy consumption by Phase II pollution control equipment represents only 1 percent of the energy requirements for iron and steel production.

EMPLOYMENT IMPACT

Operation of the water pollution control equipment required to comply with the Phase II Effluent Guidelines will result in additional jobs as follows:

EMPLOYMENT EFFECTS OF EFFLUENT GUIDELINES
(thousands of jobs)

	Short Run 1977	Long Run 1983
To meet BPCTCA	0.72	1.51
To meet BATEA	0.04	1.49
To meet NSPS	-	0.05
TOTAL	0.76	3.05

Nearly 800 jobs are associated with these guidelines by 1977 and the total will exceed 3,000 jobs by 1983.

EXHIBITS

EXHIBIT 1

DOMESTIC STEEL SHIPMENTS 1960-1983
(MILLIONS OF TONS)

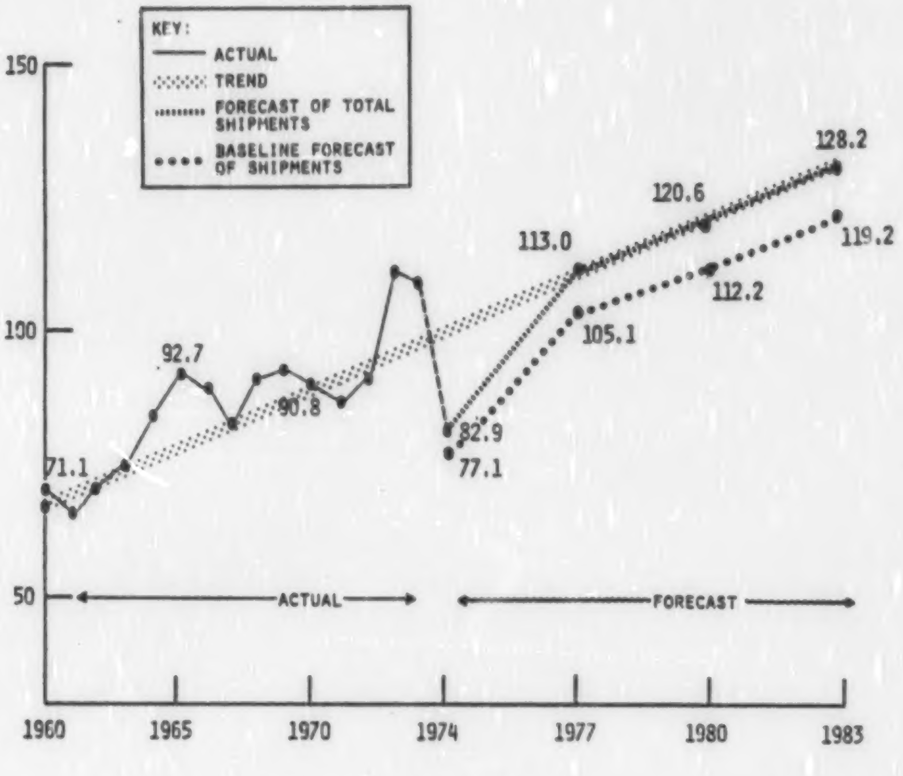

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Exhibit 2

CAPITAL EXPENDITURES FOR CAPACITY EXPANSION BY TIME PERIOD

1975-1983

(billions of 1975 dollars)

	1975-1977	1978-1980	1981-1983	1975-1983
Process Equipment Placed into Service				
Raw Materials Preparation	$0.34	$0.66	$0.64	$1.64
Ironmaking	-	0.28	0.36	0.65
Steelmaking	0.55	0.51	0.47	1.53
Casting and Forming	0.35	0.68	0.96	1.99
Finishing Mills	2.09	0.78	0.94	3.80
Subtotal	$3.33	$2.90	$3.38	$9.61
Changes in Construction Work in Progress	0.40	0.61	0.99	2.01
Total	$3.73	$3.51	$4.37	$11.62

Exhibit 3

CAPITAL EXPENDITURES FOR REWORKS AND MODERNIZATION BY TIME PERIOD

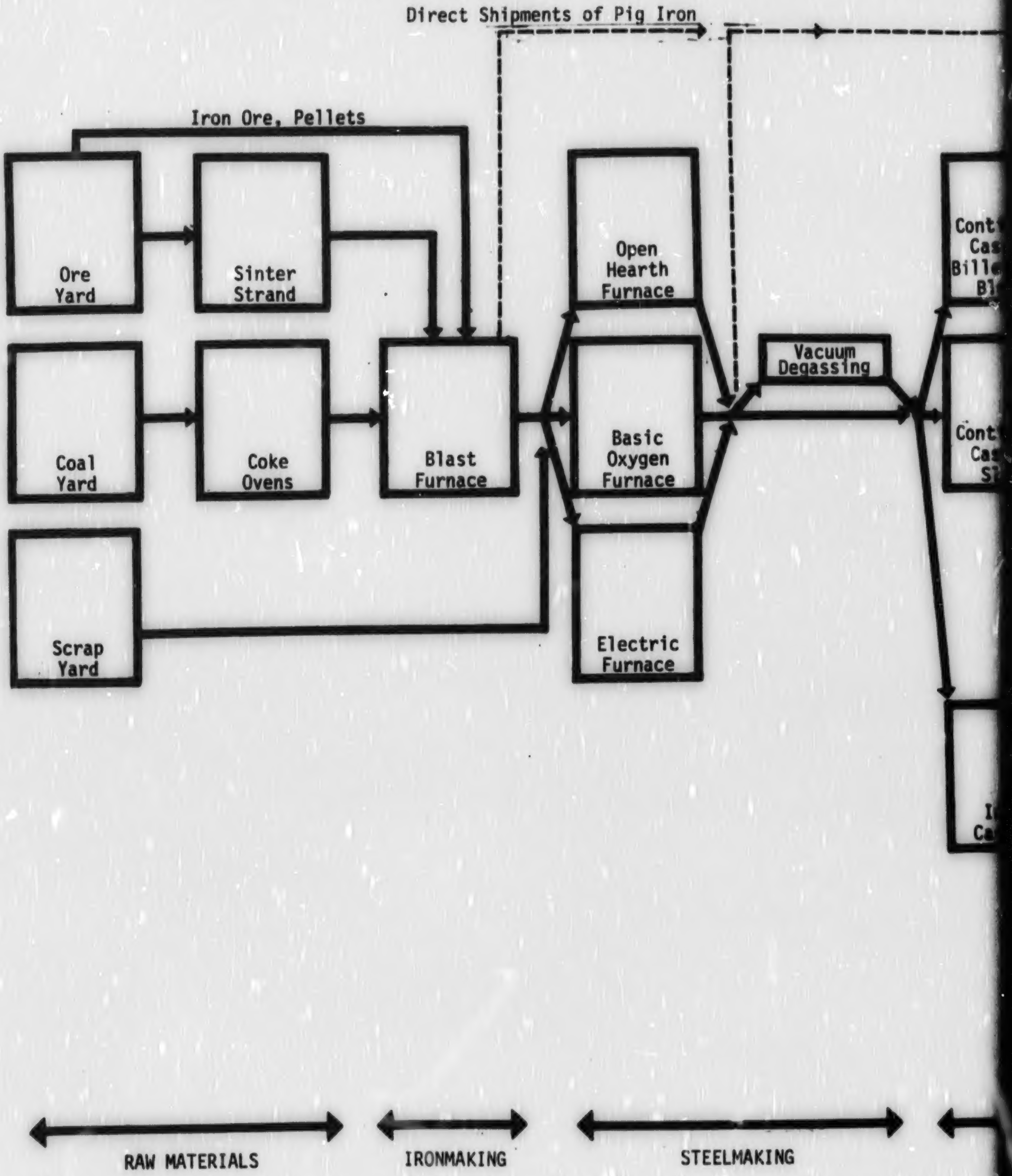
1975-1983

(billions of 1975 dollars)

	1975-1977	1978-1980	1981-1983	1975-1983
Process Equipment Placed into Service				
Raw Materials Preparation	$0.47	$0.52	$0.58	$1.58
Ironmaking	0.52	0.53	0.56	1.61
Steelmaking	0.15	0.17	0.19	0.51
Casting and Forming	1.05	1.08	1.11	3.24
Finishing Mills	2.80	3.03	3.13	8.95
Total	$4.99	$5.34	$5.56	$15.89

Exhibit 4

SCHEMATIC OF STEEL PRODUCTION


Direct Shipments of Pig Iron
Iron Ore, Pellets
Ore Yard
Sinter Strand
Coal Yard
Coke Ovens
Blast Furnace
Scrap Yard
Open Hearth Furnace
Basic Oxygen Furnace
Electric Furnace
Vacuum Degassing
Cont
Cas
Bille
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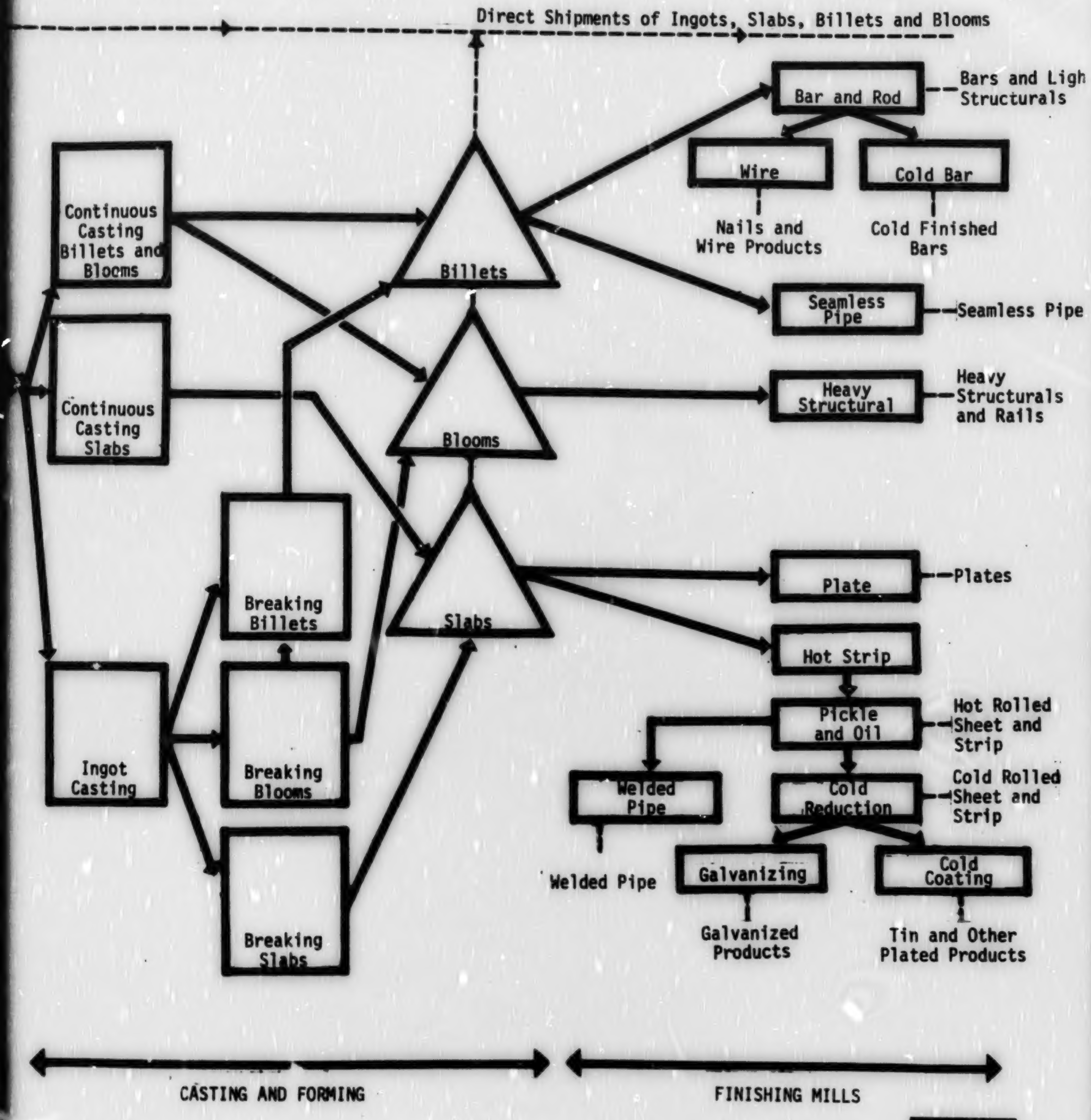
Sl
I
Ca
RAW MATERIALS
IRONMAKING
STEELMAKING

TION PROCESS



Direct Shipments of Ingots, Slabs, Billets and Blooms
Continuous Casting Billets and Blooms
Continuous Casting Slabs
Ingot Casting
Breaking Billets
Breaking Blooms
Breaking Slabs
Billets
Blooms
Slabs
Bar and Rod
Bars and Ligh Structurals
Wire
Cold Bar
Nails and Wire Products
Cold Finished Bars
Seamless Pipe
Seamless Pipe
Heavy Structural
Heavy Structurals and Rails
Plate
Plates
Hot Strip
Pickle and Oil
Hot Rolled Sheet and Strip
Welded Pipe
Cold Reduction
Cold Rolled Sheet and Strip
Welded Pipe
Galvanizing
Cold Coating
Galvanized Products
Tin and Other Plated Products
CASTING AND FORMING
FINISHING MILLS

Exhibit 5

OPERATIONS AND MAINTENANCE EXPENSES FOR IRON AND STEEL PRODUCTION BY TIME PERIOD

1975-1983

(billions of 1975 dollars)

	1975-1977	1978-1980	1981-1983	1975-1983
Process Equipment				
Raw Materials Preparation	$40.03	$51.56	$58.68	$150.27
Ironmaking	0.90	1.10	1.14	3.15
Steelmaking	13.78	16.19	16.63	46.60
Casting and Forming	5.06	6.55	7.25	18.86
Finishing Mills	17.50	21.17	22.37	61.03
Total	$77.27	$96.56	$106.07	$279.91

Exhibit 6

OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT PLACED INTO SERVICE PRIOR TO 1975 BY TIME PERIOD

1975-1983

(billions of 1975 dollars)

	1975-1977	1978-1980	1981-1983	1975-1983
Process Equipment				
Raw Materials Preparation	$0.10	$0.12	$0.12	$0.34
Ironmaking	0.10	0.12	0.12	0.35
Steelmaking	0.06	0.06	0.07	0.19
Casting and Forming	0.03	0.03	0.03	0.09
Finishing Mills	0.39	0.46	0.48	1.32
Total	$0.68	$0.79	$0.82	$2.29

Exhibit 7

OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT PLACED INTO SERVICE PRIOR TO 1975 BY TIME PERIOD

1975-1983

(billions of 1975 dollars)

	1975-1977	1978-1980	1981-1983	1975-1983
Process Equipment				
Raw Materials Preparation	$0.01	$0.02	$0.02	$0.05
Ironmaking	-	-	-	-
Steelmaking	0.20	0.21	0.20	0.62
Casting and Forming	-	-	-	-
Finishing Mills	-	-	-	-
Total	$0.22	$0.23	$0.22	$0.67

Exhibit 8

CAPITAL EXPENDITURES FOR WATER POLLUTION CONTROL EQUIPMENT BY TIME PERIOD

NUS/Cyrus Rice Engineering Cost Estimates

1975-1983

(billions of 1975 dollars)

	1975-1977	1978-1980	1981-1983	1975-1983
Process Equipment Placed into Service				
Raw Materials Preparation	$0.01	$0.03	$0.06	$0.10
Ironmaking	0.04	0.05	0.04	0.13
Steelmaking	0.06	0.04	0.06	0.15
Casting and Forming	0.11	0.14	0.12	0.37
Finishing Mills	0.59	0.69	0.45	1.74
Subtotal	$0.81	$0.95	$0.73	$2.49
Changes in Construction Work in Progress	0.77	(0.14)	(0.29)	0.34
Total	$1.58	$0.81	$0.44	$2.83
Storm Runoff[1]	0.02	0.08	0.05	0.15
Other Water[1]	0.16	0.29	0.15	0.60
Grand Total	$1.76	$1.18	$0.64	$3.57

[1] Includes changes in construction work in progress

Exhibit 9

CAPITAL EXPENDITURES FOR WATER POLLUTION CONTROL EQUIPMENT BY EFFLUENT GUIDELINE

NUS/Cyrus Rice Engineering Cost Estimates

1975-1983

(billions of 1975 dollars)

	Effluent Guidelines			Total
	BPCTCA	BATEA	NSPS	
Process Equipment Placed Into Service				
Raw Materials Preparation	$0.01	$0.07	$0.01	$0.10
Ironmaking	0.08	0.04	0.02	0.13
Steelmaking	0.03	0.06	0.06	0.15
Casting and Forming	0.15	0.07	0.15	0.37
Finishing Mills	1.12	0.57	0.04	1.74
Subtotal	$1.39	$0.81	$0.28	$2.49
Changes in Construction Work in Progress	0.15	0.06	0.13	0.34
Total	$1.54	$0.87	$0.41	$2.83
Storm Runoff[1]				0.15
Other Water[1]				0.60
Grand Total				$3.57

---

[1] Includes changes in construction work in progress

Exhibit 10

OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT BY TIME PERIOD

NUS/Cyrus Rice Engineering Cost Estimates
1975-1983
(billions of 1975 dollars)

	1975-1977	1978-1980	1981-1983	1975-1983
Process Equipment				
Raw Materials Preparation	$0.11	$0.16	$0.23	$0.50
Ironmaking	0.11	0.15	0.21	0.47
Steelmaking	0.08	0.11	0.14	0.32
Casting and Forming	0.04	0.09	0.11	0.24
Finishing Mills	0.50	0.84	1.01	2.35
Subtotal	$0.84	$1.35	$1.70	$3.88
Storm Runoff	*	0.02	0.09	0.10
Other Water	0.03	0.18	0.63	0.85
Grand Total	$0.87	$1.55	$2.42	$4.83

*less than $5 million

Exhibit 11

OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT BY EFFLUENT GUIDELINE

NUS/Cyrus Rice Engineering Cost Estimates

1975-1983

(billions of 1975 dollars)

	Effluent Guidelines			
	BPCTCA	BATEA	NSPS	Total
Process Equipment				
Raw Materials Preparation	$0.37	$0.10	$0.03	$0.50
Ironmaking	0.37	0.09	0.01	0.47
Steelmaking	0.20	0.06	0.06	0.32
Casting and Forming	0.17	0.02	0.05	0.24
Finishing Mills	2.20	0.14	0.01	2.35
Subtotal	$3.31	$0.41	$0.16	$3.88
Storm Runoff				0.10
Other Water				0.85
Grand Total				$4.83

Exhibit 12

COMPARISON OF CAPITAL EXPENDITURES FOR WATER POLLUTION CONTROL EQUIPMENT

NUS/Cyrus Rice vs. Arthur D. Little Engineering Cost Estimates

In Place 1974 vs. Additions 1975-1983

(billions of 1975 dollars)

	NUS/Cyrus Rice Engineering Cost Estimates			Arthur D. Little Engineering Cost Estimates		
	In Place 1974	Additions 1975-1983	Total	In Place 1974	Additions 1975-1983	Total
Process Equipment Placed into Service						
Raw Materials Preparation	$0.50	$0.10	$0.59	$0.33	$0.80	$1.13
Ironmaking	0.28	0.13	0.42	0.39	0.61	1.00
Steelmaking	0.17	0.15	0.32	0.15	0.17	0.32
Casting and Forming	0.13	0.37	0.50	0.09	0.35	0.43
Finishing Mills	0.42	1.74	2.15	0.43	1.45	1.88
Subtotal[1]	$1.50	$2.49	$3.98	$1.39	$3.38	$4.76

---

[1] Process equipment only

Exhibit 13

COMPARISON OF OPERATIONS AND MAINTENANCE EXPENSES FOR WATER POLLUTION CONTROL EQUIPMENT

NUS/Cyrus Rice vs. Arthur D. Little Engineering Cost Estimates

1975-1983

(billions of 1975 dollars)

	NUS/Cyrus Rice Engineering Cost Estimates			Arthur D. Little Engineering Cost Estimates		
	Equipment In Place	Equipment Additions	Total 1975-1983	Equipment In Place	Equipment Additions	Total 1975-1983
Process Equipment						
Raw Materials Preparation	$0.34	$0.16	$0.50	$0.59	$0.49	$1.09
Ironmaking	0.35	0.12	0.47	0.36	0.87	1.24
Steelmaking	0.19	0.13	0.32	0.14	0.08	0.22
Casting and Forming	0.09	0.15	0.24	0.08	0.22	0.30
Finishing Mills	1.32	1.03	2.35	0.34	1.04	1.37
Subtotal[1]	$2.29	$1.59	$3.88	$1.51	$2.70	$4.22

---

[1] Process equipment only

Exhibit 14

CAPITAL EXPENDITURES FOR AIR POLLUTION CONTROL EQUIPMENT BY TIME PERIOD

Battelle Columbus Laboratories Engineering Cost Estimates

1975-1983

(billions of 1975 dollars)

	1975-1977	1978-1980	1981-1983	1975-1983
Process Equipment Placed into Service				
Raw Materials Preparation	$0.64	$0.68	$0.06	$1.37
Ironmaking	-	0.36	0.01	0.37
Steelmaking	0.27	0.48	0.13	0.88
Casting and Forming	-	-	-	-
Finishing Mills	-	-	-	-
Subtotal	$0.91	$1.52	$0.20	$2.62
Changes in Construction Work in Progress	1.05	(0.69)	0.01	0.37
Total	$1.96	$0.83	$0.21	$2.99
Other Air[1]	0.13	0.08	0.04	0.26
Grand Total	$2.09	$0.91	$0.25	$3.25

---

[1] Includes changes in construction work in progress

Exhibit 15

CAPITAL EXPENDITURES FOR AIR POLLUTION CONTROL EQUIPMENT BY EMISSION STANDARD

Battelle Columbus Laboratories Engineering Cost Estimates

1975-1983

(billions of 1975 dollars)

	Emission Standard		
	Stack	Fugitives	Total
Process Equipment Placed into Service			
Raw Materials Preparation	$0.93	$0.44	$1.37
Ironmaking	-	0.37	0.37
Steelmaking	0.49	0.39	0.88
Casting and Forming	-	-	-
Finishing Mills	-	-	-
Subtotal	$1.42	$1.20	$2.62
Changes in Construction Work in Progress	0.23	0.14	0.37
Total	$1.65	$1.34	$2.99
Other Air[1]			0.26
Grand Total			$3.25

---

[1] Includes changes in construction work in progress

Exhibit 15

OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT BY TIME PERIOD

Battelle Columbus Laboratories Engineering Cost Estimates

1975-1983

(billions of 1975 dollars)

	1975-1977	1975-1980	1981-1983	1975-1983
Process Equipment				
Raw Materials Preparation	$0.19	$0.59	$0.70	$1.48
Ironmaking	-	0.12	0.20	0.32
Steelmaking	0.21	0.35	0.42	0.98
Casting and Forming	-	-	-	-
Finishing Mills	-	-	-	-
Subtotal	$0.40	$1.06	$1.32	$2.78
Other Air	0.02	0.07	0.13	0.22
Grand Total	$0.42	$1.13	$1.45	$3.00

Exhibit 17

OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT BY EMISSION STANDARD

Battelle Columbus Laboratories Engineering Cost Estimates
1975-1983
(billions of 1975 dollars)

	Emission Standard		
	Stack	Fugitives	Total
Process Equipment			
Raw Materials Preparation	$0.99	$0.50	$1.48
Ironmaking	-	0.32	0.32
Steelmaking	0.65	0.33	0.98
Casting and Forming	-	-	-
Finishing Mills	-	-	-
Subtotal	$1.64	$1.15	$2.78
Other Air			0.22
Grand Total			$3.00

Exhibit 18

COMPARISON OF CAPITAL EXPENDITURES FOR AIR POLLUTION CONTROL EQUIPMENT

Battelle Columbus Laboratories vs. Arthur D. Little Engineering Cost Estimates

In Place 1974 vs. Additions 1975-1983

(billions of 1975 dollars)

	Battelle Columbus Laboratories Engineering Cost Estimates			Arthur D. Little Engineering Cost Estimates		
	In Place 1974	Additions 1975-1983	Total	In Place 1974	Additions 1975-1983	Total
Process Equipment Placed into Service						
Raw Materials Preparation	*	$1.37	$1.37	$0.11	$1.48	$1.58
Ironmaking	-	0.37	0.37	-	0.82	0.82
Steelmaking	0.68	0.88	1.56	0.66	3.50	4.16
Casting and Forming	-	-	-	-	0.09	0.09
Finishing Mills	-	-	-	-	0.01	0.01
Subtotal[1]	$0.68	$2.62	$3.30	$0.77	$5.90	$6.66

*Less than $5 million

[1] Process equipment only

Exhibit 19

COMPARISON OF OPERATIONS AND MAINTENANCE EXPENSES FOR AIR POLLUTION CONTROL EQUIPMENT

Battelle Columbus Laboratories vs. Arthur D. Little Engineering Cost Estimates

1975-1983

(billions of 1975 dollars)

	Battelle Columbus Laboratories Engineering Cost Estimates			Arthur D. Little Engineering Cost Estimates		
	Equipment In Place	Equipment Additions	Total 1975-1983	Equipment In Place	Equipment Additions	Total 1975-1983
Process Equipment						
Raw Materials Preparation	$0.05	$1.43	$1.48	$0.07	$1.44	$1.50
Ironmaking	-	0.32	0.32	-	0.74	0.74
Steelmaking	0.62	0.36	0.98	0.80	2.83	3.64
Casting and Forming	-	-	-	-	0.81	0.81
Finishing Mills	-	-	-	-	0.37	0.37
Subtotal[1]	$0.67	$2.11	$2.78	$0.87	$6.19	$7.06

[1] Process equipment only

Exhibit 20

SCHEMATIC OF TBS METHODOLOGY FOR ESTIMATING REVENUE REQUIREMENTS AND EXTERNAL FINANCING NEEDS

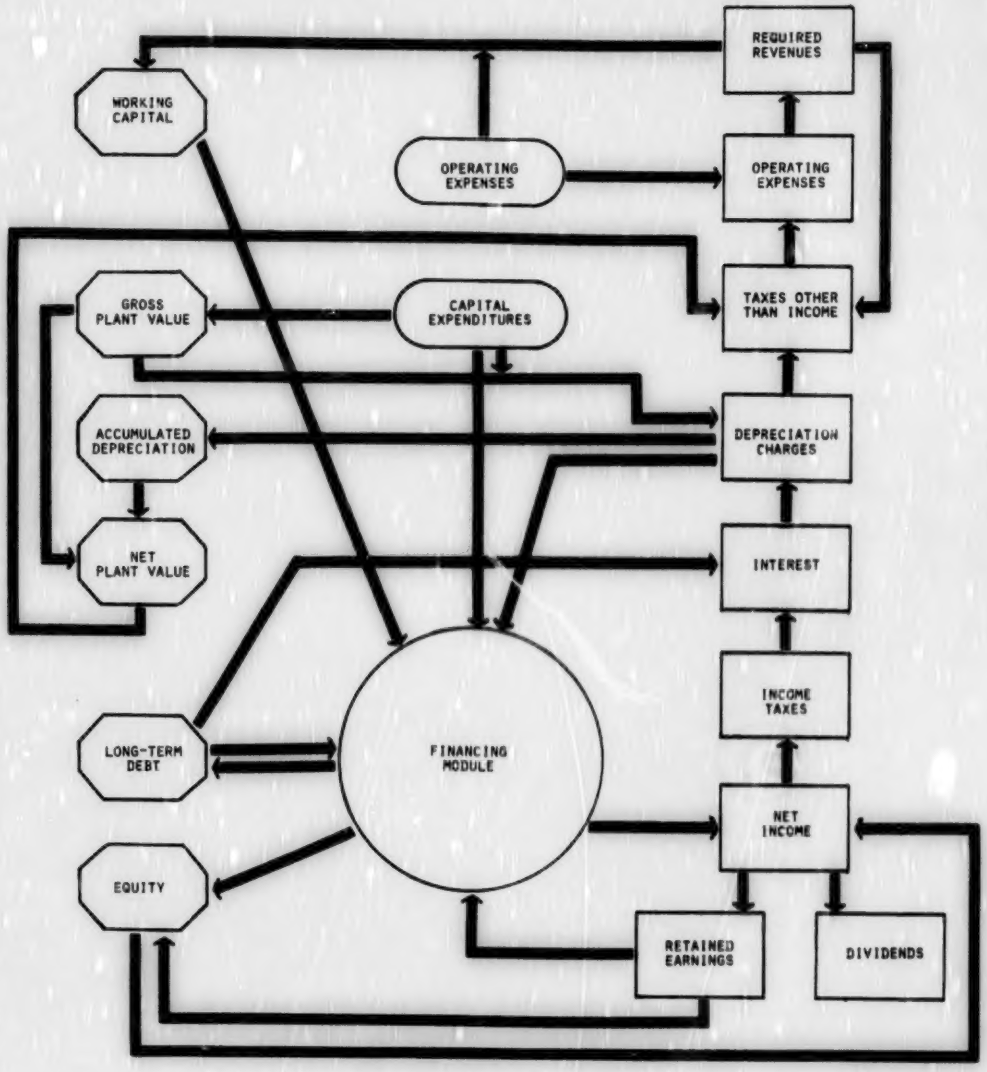

REQUIRED REVENUES
WORKING CAPITAL
OPERATING EXPENSES
OPERATING EXPENSES
TAXES OTHER THAN INCOME
GROSS PLANT VALUE
CAPITAL EXPENDITURES
ACCUMULATED DEPRECIATION
DEPRECIATION CHARGES
NET PLANT VALUE
INTEREST
INCOME TAXES
LONG-TERM DEBT
FINANCING MODULE
NET INCOME
EQUITY
RETAINED EARNINGS
DIVIDENDS

Exhibit 21

REVENUE REQUIREMENTS FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT

1975-1983

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment	
		Water	Air
Cost Category			
Sales Taxes	$13.44	$0.23	$0.23
Operations and Maintenance Expenses	282.87	2.53	2.34
Depreciation	13.76	0.83	0.90
Property Taxes	3.15	0.27	0.27
Net Interest Charges	4.41	0.41	0.45
Federal and State Income Taxes	7.06	0.50	0.51
Net Income	13.92	0.98	1.00
Total	$338.61	$5.75	$5.68

---

[1] Includes pollution control equipment placed into service prior to 1975.

Exhibit 22

REVENUE REQUIREMENTS FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT BY TIME PERIOD

1975-1983

(billions of 1975 dollars)

	1975-1977	1978-1980	1981-1983	1975-1983
Source of Requirements[1]				
Iron and Steel Production	$94.87	$114.54	$125.55	$334.95
Water PCE In Place	0.93	0.95	0.93	2.80
Air PCE In Place	0.32	0.29	0.26	0.85
Total Baseline	$96.11	$115.78	$126.73	$338.61
Additional Water PCE to meet:				
BPCTCA Guideline	$0.58	$1.20	$1.11	$2.90
BATEA Guideline	0.03	0.21	0.67	0.92
NSPS Guideline	0.03	0.14	0.24	0.41
Storm Runoff Guideline	*	0.04	0.16	0.20
Other Water Requirements	0.07	0.32	0.93	1.32
Total Water	$0.73	$1.92	$3.11	$5.75
Additional Air PCE to meet:				
Stack Emission Standard	$0.69	$1.10	$1.00	$2.78
Fugitives Emission Standard	0.10	0.99	1.35	2.44
Other Air Requirements	0.07	0.16	0.24	0.47
Total Air	$0.86	$2.24	$2.59	$5.68

*less than $5 million

[1] Pollution control equipment denoted as PCE

Exhibit 23

AVERAGE PRICE EFFECTS FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT FOR SELECTED YEARS

1974-1983

(1975 dollars per ton of steel shipments)

	1974	1977	1980	1983
Source of Effect[1]				
Iron and Steel Production	$361.09	$341.17	$350.76	$361.96
Water PCE In Place	3.61	3.12	2.79	2.57
Air PCE In Place	1.32	0.99	0.81	0.68
Baseline Price	$366.01	$345.28	$354.36	$365.21
Additional Water PCE to meet:				
BPCTCA Guideline		$2.62	$3.64	$2.96
BATEA Guideline		0.19	0.93	2.22
NSPS Guideline		0.21	0.50	0.80
Storm Runoff Guideline		0.02	0.19	0.53
Other Water Requirements		0.38	1.30	3.09
Total Water		$3.42	$6.56	$9.60
Additional Air PCE to meet:				
Stack Emission Standard		$2.98	$3.15	$2.70
Fugitives Emission Standard		0.54	4.04	3.70
Other Air Requirements		0.30	0.54	0.75
Total Air		$3.82	$7.73	$7.15

---

[1] Pollution control equipment denoted as PCE

Exhibit 24

PRICE EFFECTS FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT BY STEEL PRODUCT

1983

(1975 dollars per ton of steel product)

	Baseline Conditions[1]	Pollution Control Equipment	
		Water	Air
Steel Product			
Direct Shipments of Ingots, Blooms, Billets and Slabs	$219.68	$3.36	$4.63
Heavy Structurals and Rails	281.95	5.84	5.96
Nails and Wire Products	482.25	16.06	9.25
Bars and Light Structurals	330.59	9.81	7.02
Cold Finished Bars	332.18	11.47	7.04
Seamless Pipe and Tubing	384.88	10.25	7.66
Welded Pipe	417.35	11.99	7.45
Hot Rolled Sheet and Strip	289.28	6.69	5.77
Galvanized Products	492.63	13.95	9.15
Tin and Other Plated Products	521.56	14.60	9.43
Cold Rolled Sheet and Strip	406.48	11.24	8.01
Plates	367.03	7.17	6.54

[1] Includes pollution control equipment placed into service prior to 1975.

Exhibit 25

PRICE EFFECTS FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT BY STAGE OF PRODUCTION[1]

1983

(1975 dollars per ton of steel production)

	Baseline Conditions[2]	Pollution Control Equipment	
		Water	Air
Process Equipment			
Raw Materials Preparation	$182.98	$1.00	$3.10
Ironmaking	8.12	0.89	1.25
Steelmaking	54.23	0.94	2.80
Casting and Forming	30.36	1.49	-
Finishing Mills	89.52	5.28	-
Total	$365.21	$9.60	$7.15

[1] Price effects are computed on the basis of a weighted average of steel products and process-by-process yields.

[2] Includes pollution control equipment placed into service prior to 1975.

Exhibit 26

PRICE EFFECTS FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT BY PROCESS[1]

1983

(1975 dollars per ton of unit operation output)

	Baseline Conditions[2]	Pollution Control Equipment	
		Water	Air
Process Equipment			
Ore Yard	$34.32	$0.03	-
Coal Yard	60.09	0.03	-
Scrap Yard	114.81	0.03	-
Sinter Strand	12.32	0.13	$1.04
Coke Oven	4.27	2.66	5.38
Blast Furnace	8.63	0.97	1.40
Open Hearth Furnace	56.55	0.86	3.59
Basic Oxygen Furnace	29.14	0.42	1.16
Electric Furnace	56.45	0.48	3.63
Vacuum Degassing	0.44	0.60	-
Ingot Casting	4.71	0.06	-
Billet Caster	13.35	0.82	-
Slab Caster	45.23	0.90	-
Blooming Mill	19.63	1.18	-
Billet Mill	29.75	1.79	-
Slabbing Mill	8.30	0.91	-
Structural Mill	19.22	1.75	-
Bar Mill	54.49	4.75	-
Wire Mill	135.13	5.76	-
Cold Finishing	1.59	1.67	-
Seamless Pipe Mill	86.40	4.78	-
Hot Strip Mill	36.98	2.35	-
Pickling	13.43	1.64	-
Welded Pipe Mill	76.91	3.27	-
Cold Reduction	56.84	2.29	-
Galvanizing	69.89	2.26	-
Tin Plating	98.82	2.91	-
Plate Mill	79.41	2.96	-

[1] Price effects represent value added (including the purchase of raw materials) at each unit operation.

[2] Includes pollution control equipment placed into service prior to 1975.

Exhibit 27

SOURCES AND APPLICATIONS OF FUNDS FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT

1975-1977

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment	
		Water	Air
Applications of Funds			
Capital Expenditures	$8.72	$1.76	$2.09
Increase in Working Capital	1.15	0.02	0.04
Refunding of Long-Term Debt	0.47	-	-
Total Applications	$10.34	$1.78	$2.13
Sources of Funds			
Depreciation	$4.31	$0.07	$0.09
Retained Earnings	2.25	0.12	0.14
Subtotal--Internal Sources	$6.56	$0.19	$0.23
Issues of Long-Term Debt	$2.29	$0.43	$0.53
Issues of Common Stock	1.49	1.15	1.37
Subtotal--External Financing	$3.77	$1.59	$1.90
Total Sources	$10.34	$1.78	$2.13

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[1] Includes pollution control equipment placed into service prior to 1975.

Exhibit 28

SOURCES AND APPLICATIONS OF FUNDS FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT

1975-1983

(billions of 1975 dollars)

	Baseline Conditions[1]	Pollution Control Equipment	
		Water	Air
Applications of Funds			
Capital Expenditures	$27.50	$3.57	$3.25
Increase in Working Capital	4.21	0.21	0.19
Refunding of Long-Term Debt	1.22	-	-
Total Applications	$32.93	$3.78	$3.44
Sources of Funds			
Depreciation	$13.76	$0.83	$0.90
Retained Earnings	6.18	0.47	0.48
Subtotal--Internal Sources	$19.94	$1.29	$1.38
Issues of Long-Term Debt	$6.19	$0.75	$0.66
Issues of Common Stock	6.79	1.73	1.40
Subtotal--External Financing	$12.99	$2.49	$2.06
Total Sources	$32.93	$3.78	$3.44

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[1] Includes pollution control equipment placed into service prior to 1975.

Exhibit 29

EXTERNAL FINANCING REQUIREMENTS FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT BY TIME PERIOD

1975-1983

(billions of 1975 dollars)

	1975-1977	1978-1980	1981-1983	1975-1983
Source of Requirements[1]				
Iron and Steel Production	$3.74	$4.80	$4.69	$13.23
Water PCE In Place	0.04	(0.10)	(0.09)	(0.15)
Air PCE In Place	(0.01)	(0.05)	(0.04)	(0.09)
Total Baseline	$3.77	$4.65	$4.56	$12.99
Additional Water PCE to meet:				
BPCTCA Guideline	$1.20	$(0.07)	$(0.29)	$0.84
BATEA Guideline	0.12	0.45	0.14	0.71
NSPS Guideline	0.11	0.10	0.13	0.33
Storm Runoff Guideline	0.02	0.08	0.03	0.12
Other Water Requirements	0.15	0.26	0.09	0.49
Total Water	$1.59	$0.81	$0.09	$2.49
Additional Air PCE to meet:				
Stack Emission Standard	$1.16	$(0.08)	$(0.15)	$0.93
Fugitives Emission Standard	0.62	0.51	(0.17)	0.95
Other Air Requirements	0.12	0.06	*	0.18
Total Air	$1.90	$0.48	$(0.32)	$2.06

*Less than $5 million

[1] Pollution Control Equipment denoted as PCE.

Exhibit 30

ENERGY CONSUMPTION FOR IRON AND STEEL PRODUCTION BY TIME PERIOD

1975-1983

(quadrillion Btu)

	1975-1977	1978-1980	1981-1983	1975-1983
Process Equipment				
Raw Materials Preparation	4.28	5.11	5.40	14.79
Ironmaking	(1.07)	(1.26)	(1.34)	(3.67)
Steelmaking	0.82	0.93	0.96	2.71
Casting and Forming	0.74	0.87	0.87	2.48
Finishing Mills	1.82	2.15	2.28	6.25
Total	6.59	7.80	8.17	22.56

Exhibit 31

ENERGY CONSUMPTION FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT BY TIME PERIOD

1975-1983

(quadrillion Btu)

	1975-1977	1978-1980	1981-1983	1975-1983
Source of Consumption[1]				
Iron and Steel Production	6.59	7.80	8.17	22.56
Water PCE In Place	0.05	0.06	0.06	0.17
Air PCE In Place	0.07	0.08	0.07	0.22
Total Baseline	6.71	7.94	8.30	22.95
Additional Water PCE to meet:				
BPCTCA Guideline	0.03	0.10	0.11	0.24
BATEA Guideline	-	0.01	0.05	0.06
NSPS Guideline	-	0.01	0.02	0.03
Total Water	0.03	0.12	0.18	0.33
Additional Air PCE to meet:				
Stack Emission Standard	0.01	0.01	0.02	0.04
Fugitive Emission Standard	-	0.03	0.04	0.07
Total Air	0.01	0.04	0.06	0.11
Total Energy Consumption	6.75	8.10	8.54	23.39

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[1] Pollution control equipment denoted as PCE.

Exhibit 32

EMPLOYMENT FOR IRON AND STEEL PRODUCTION FOR SELECTED YEARS

1974-1983

(thousands of jobs)

	1974	1977	1980	1983
Process Equipment				
Raw Materials Preparation	54.8	52.9	52.9	52.5
Ironmaking	21.9	21.3	21.2	21.0
Steelmaking	120.0	111.2	107.6	104.1
Casting and Forming	73.5	71.6	75.4	78.7
Finishing Mills	194.2	185.2	185.9	185.8
Total	464.4	442.3	443.0	442.1

Exhibit 33

EMPLOYMENT FOR INDUSTRY BASELINE AND WATER AND AIR POLLUTION CONTROL EQUIPMENT[1] FOR SELECTED YEARS

1974-1983

(thousands of jobs)

	1974	1977	1980	1983
Source of Employment[2]				
Iron and Steel Production	464.4	442.3	443.0	442.1
Water PCE In Place	2.0	2.0	2.0	2.0
Air PCE In Place	0.4	0.4	0.4	0.4
Total Baseline	466.8	444.7	445.4	444.5
Additional Water PCE to meet:				
BPCTCA Guideline		0.8	1.6	1.7
BATEA Guideline		0.1	0.3	1.0
NSPS Guideline		0.1	0.2	0.4
Other Water Requirements		0.4	1.9	5.9
Total Water		1.4	3.0	9.0
Additional Air PCE to meet:				
Stack Emission Standard		0.1	0.1	0.1
Fugitive Emission Standard		-	2.3	2.4
Other Air Requirements		0.3	0.6	1.0
Total Air		0.4	3.0	3.5
Total Employment		446.5	451.4	457.0

[1] Includes process-related direct and indirect employees only.

[2] Pollution control equipment denoted as PCE.